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JUNE, 1982 FINAL REPORT

USERS' GUIDE

Volume 1

LITERATURE AND DATA SEARCH OF WATER RESOURCE INFORMATION OF THE COLORADO, UTAH, AND WYOMING OIL SHALE BASINS

LEWIN AND ASSOCIATES, INC.
Denver, Colorado Washington, D.C.

BUREAU OF LAND MANAGEMENT

Contract YA-553-CT1-1093

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USERS' GUIDE

Volume 1

Developed By
Lewin and Associates, Inc.
Denver, Colorado Washington, D.C.

For The
Colorado State Office
Bureau Of Land Management
U. S. Department Of Interior
Denver, Colorado

Contract No. YA-553-CT1-1093

JUNE 1982

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Volume 3: Bibliography of Water Resources Literature

Volume 4: Bibliography of Water Resources Literature

Volume 5: Bibliography of Water Resources Literature

Volume 6: Topical Bibliography of Water Resources Literature

Volume 7: Listing of Personnel and Agencies

Volume 8: Colorado Data Compilations

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PREFACE

In October of 1981, the Colorado State Office of the Bureau of Land Management contracted with Lewin and Associates, Inc., to undertake a comprehensive literature search of the water resource data available for oil shale regions of Colorado, Wyoming, and Utah. The study areas are depicted in Exhibit 1.

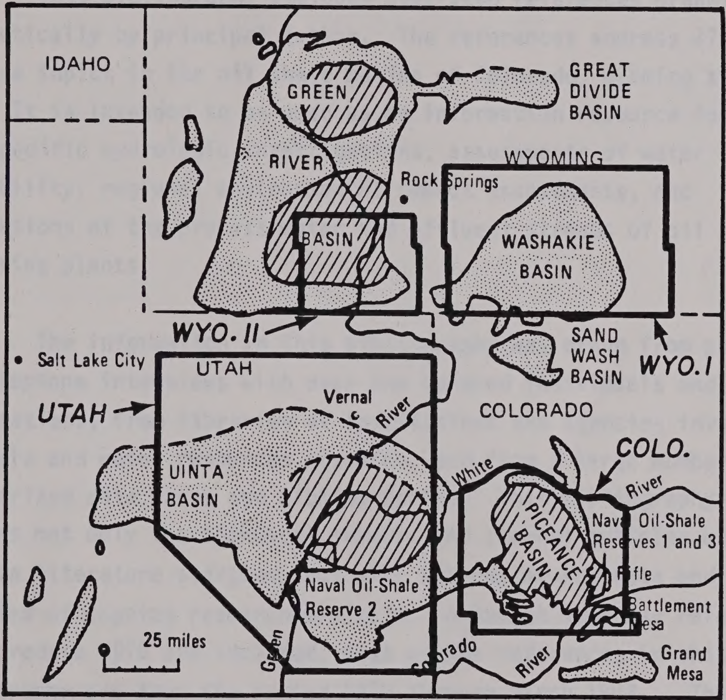
Under the guidance of Mr. Steve Vandas, Colorado State Hydrologist, and with the active cooperation of Mr. Boyd Christiansen, Utah State Hydrologist, and Mr. Cliff Franklin, Wyoming State Hydrologist, the Lewin staff undertook to survey numerous public and private data collections and libraries as well as conduct over two hundred interviews with local experts. Mr. Paul Sommers of the BLM's Special Projects Office offered invaluable advice.

Acknowledgements for assistance in completing this study are not only due to all those individuals and organizations referenced in the Listing of Personnel and Agencies, Volume 7, but thanks are also due to numerous unlisted individuals who helped us find the "right" people and publications.

The professional project staff under the management of Mr. Donald Wicks performed admirably and they often committed long hours to reviewing and checking and rechecking data and references included in this study. Dr. J. P. Fox of J. Phyllis Fox Consulting Services contributed greatly to the substance and quality of this report, and the study could not have been undertaken without her unique contribution. Ms. Kathy Thompson, Ms. Elizabeth Haymen, Mr. John Flambard, and Mr. Michael Burgess provided the professional expertise and cartographic skills necessary for the clear presentation and organization of this report.

Jack M. Appleman, Project Director
July 1, 1982

STUDY AREAS OF THE COLORADO, UTAH, AND WYOMING OIL SHALE BASINS


IDAHO
GREEN
RIVER
BASIN
GREAT
DIVIDE
BASIN
WYOMING
Rock Springs
WASHAKIE
BASIN
WYO. II
SAND
WASH
BASIN
WYO. I
Salt Lake City
UTAH
UTAH
Vernal
River
COLORADO
COLO.
UINTA
BASIN
White
River
PICEANCE
BASIN
Naval Oil-Shale
Reserves 1 and 3
Rifle
Battlement
Mesa
Naval Oil-Shale
Reserve 2
Green
Colorado
River
Grand
Mesa
25 miles

EXPLANATION

░ Area underlain by the Green River Formation in which the oil shale is unappraised or low grade

▨ Area underlain by oil shale more than 10 feet thick, which yields 25 gallons or more oil per ton of shale

EXHIBIT 1

CHAPTER 1

A BIBLIOGRAPHY OF WATER RESOURCES LITERATURE

INTRODUCTION

This bibliography includes over 1200 references organized alphabetically by principal author. The references address 27 water resource topics in the oil shale basins of Colorado, Wyoming and Utah. It is intended to be used as an information resource for site-specific hydrologic investigations, assessments of water availability, regional environmental impact assessments, and examinations of the process water and effluent streams of oil shale processing plants.

The information in this bibliography was drawn from personal and telephone interviews with over two hundred individuals and organizations, from libraries of institutions and agencies involved in oil shale and water resources research, and from a large number of computerized data bases and bibliographies. This bibliography contains not only the technical reports and journal articles usually found in literature searches, but also sources of raw data and summaries of ongoing research projects. Although some key references which predate 1970 are included, most of the references in this bibliography are from the period 1970 through March 1982. This time frame was concentrated on because it has been a period in which intensive pre-development activity in the oil shale industry has resulted in considerable additions to the literature.

The following sections describe the reference format, the organization of the bibliography, and suggestions for its use.

CHAPTER I

A BIBLIOGRAPHY OF WATER RESOURCES LITERATURE

INTRODUCTION

This bibliography includes over [illegible] references arranged alphabetically by principal author. The references address [illegible] water resource topics in the oil shale region of Colorado, Wyoming and Utah. It is intended to be used as an information resource for site-specific hydrologic investigations, assessments of water availability, regional environmental impact assessments, and examinations of the process water and effluent streams of oil shale processing plants.

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The following sections describe the reference format, the organization of the bibliography, and suggestions for its use.

FORMAT

Each bibilographic entry contains seven types of information: accession number, reference, contact, key categories, access code, use code, and a brief abstract. A typical bibliographic entry is shown below:

SAMPLE BIBLIOGRAPHIC ENTRY

@358
Ficke, J.F., Weeks, J.B., and Welder, F.A., 1974, Hydrologic data from the Piceance Basin, Colorado: Colorado Water Resources Basic Data Release No. 31, Denver, Colorado Dept. of Natural Resources and the U.S. Geological Survey.

Contact: Lucy Laughlin (copy)

Key Categories: COLORADO, SURFACE WATER QUANTITY, SURFACE WATER QUALITY, GROUNDWATER QUANTITY, GROUNDWATER QUALITY

Access Code: 011 Use Code: 01

1. Accession Number

Each reference has a unique accession number (e.g. @358) which preceeds the citation. This number provides a quick identifier for each reference that permits rapid access to abstracts and data compilation reports.

2. Reference

The reference format used in this work is the standard U.S. Geological Survey format. For an agency author, the lowest order department, division or committee within the main agency was specified as the author. For example, the U.S. Geological Survey is specified rather than the U.S. Department of the Interior. References with an agency author are alphabetized by the first main word which is not U.S., Department or Division. For example, the U.S. Geological Survey is alphabetized by "Geological", the U.S. Department of Interior is

alphabetized by "Interior", and the Colorado Department of Health by "Colorado."

3. Contact

This component provides the name of a contact that can provide information about and/or a copy of the subject reference. The contact consists of the name of an agency or individual, followed parenthetically by an indication of the type of information available.

The first entry is the specific name of an individual or an agency which can provide additional information on the reference. The complete mailing address and telephone number for each contact is provided in the "Listing of Personnel and Agencies" volume. When an agency is listed as the contact, the telephone number is usually a main switchboard or a general information number and the "Publications Department" must be requested. The contact for national journals which are common in most public and university libraries is listed as the "Denver Public Library" (DPL).

The parenthetical entry following the contact person/agency, indicates the type of information that is available from the contact. Four source codes were used:

- Copy
- Loan
- Access
- Status

"Copy" indicates that a copy of the report can be obtained from the contact. Most federal and state agencies charge for their reports. These include NTIS, the U.S. Government Printing Office, U.S. Geological Survey Public Inquiries Offices, and the U.S. Fish and

Wildlife Service. When individuals are listed, a copy of the report is often available free of charge.

"Loan" indicates that a copy of the report can be borrowed for a limited period of time. This is indicated for reports which are out of print and are maintained in an internal library of the generating agency. Individual arrangements must be made with each contact.

"Access" indicates that a copy of the report may be inspected at its source, but that it probably cannot be removed.

"Status" indicates reports that were in preparation or in press as of March 1982. Information on report availability or project status may be obtained by contacting the specified individual.

4. Key Categories

Each reference was categorized by one or more of the 27 available topical key words depending on its contents and potential use. These key words (listed on page 7) were used in a computerized system to develop the Topical Bibliographies.

5. Access Code

This three-digit numeric code indicates where the report was inspected during our field work and its availability in Lewin libraries and files. These codes are summarized below:

DEFINITION OF FIRST TWO DIGITS OF ACCESS CODE

01	Lewin-West
02	Lewin-East
03	Oil Shale Task Force, Univ. Colorado, Denver
04	Denver Research Institute
05	Colorado Geological Society
06	Colo. State Engineer
07	BLM Denver Special Projects Office
08	BLM Grand Junction, Colo.
09	BLM Glenwood Springs, Colo.
10	BLM Craig, Colo.
11	BLM Vernal, Utah
12	Bureau of Reclamation Grand Junction, Colo.
13	Area Oil Shale Office
14	USGS Meeker, Colo.
15	BLM Cheyenne, Wyo.
16	Utah Water Research Lab
17	Univer. of Calif. Berkeley
18	USBR Salt Lake City
19	USGS Salt Lake City
20	Geokinetics Seep Ridge Road site, Utah
21	Library of Congress
22	BLM Rock Springs, Wyo.
23	BLM Rawlins, Wyo.

The first two digits are location specific and indicate where the report was first inspected. These locations may be, but are not necessarily, the same as the contact. When the location is different from the contact, the access code provides a second source for the report. The third digit indicates the availability of the report in Lewin files: a "1" indicates the report is in Lewin files, and a "2" indicates that only an abstract or summary is in Lewin files.

In a few cases a "000" access code appears. This indicates that a reference was found, but that no document or summary was located. This occurred in only a few cases and these references are included to assure that the bibliography is as complete as possible.

6. Use Code

The use code is a two-digit numeric code which provides an evaluation of the potential utility of a reference for preparation of oil shale environmental impact statements (EIS). The codes are highly subjective, reflecting the opinions and biases of the authors of this bibliography, and they do not necessarily reflect the quality of the work.

A use code of 01 indicates a principle reference for the preparation of oil shale EISs. This is an explicit recommendation that this reference be consulted. A use code of 02 is used for information reports which are accurate, well done, and timely and which supplement principle references, providing additional background and detail. A use code of 03 is used for those references which contain information that is outdated due to rapidly changing technology, or which is not directly relevant for EIS preparation. Many of the water law references are coded as 03 because this type of information is not germane to EISs and because the statutory foundations of water allocation are changing in the Upper Colorado River Basin.

7. Abstracts of Water Resources Literature

Abstracts have been prepared for over a thousand of the bibliographic references. The standard abstract format includes the bibliographic information outlined above plus the abstract itself. The abstracts are listed numerically by accession number. References lacking information to write an abstract are included in this bibliography to assure its completeness.

The abstracts were derived from three principal sources: author abstracts, Lewin-prepared abstracts, or abstracts in other annotated bibliographies. The majority of the abstracts were written or re-written by Lewin staff to reflect the special requirements of these documents. Existing abstracts were reviewed to assure that in addition to containing information on study background, purpose, and conclusions they also contained information on the geographical coverage of the study, time frame, and the type of data, tabulations, and interpretations included in the report.

A use code of 01 indicates a principle reference for the preparation of oil shale EISs. This is an explicit recommendation that this reference be consulted. A use code of 02 is used for information reports which are accurate, well done, and timely and which supplement principle references, providing additional background and detail. A use code of 03 is used for those references which contain information that is outdated due to rapidly changing technology, or which is not directly relevant for EIS preparation. Many of the water law references are coded as 03 because this type of information is not germane to EIS and because the statutory foundations of water allocation are changing in the Upper Colorado River Basin.

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The abstracts were derived from three principal sources: author abstracts, Laser-prepared abstracts, or abstracts in other annotated bibliographies. The majority of the abstracts were written or re-written by Laser staff to reflect the special requirements of these documents. Existing abstracts were reviewed to ensure that in addition to containing information on study background, purpose, and conclusions they also contained information on the geographical coverage of the study, time frame, and the type of data, calculations, and interpretations included in the report.

TOPICAL BIBLIOGRAPHIES

The 27 key categories have been used to develop 54 Topical Bibliographies which consist of references which have common groups of key categories. The references in each topical bibliography are arranged alphabetically by primary author. In order to save space only the accession numbers of references are listed. Forty two of the topical bibliographies are derived by identifying references in the following fourteen categories for each of the three states, Colorado, Utah and Wyoming:

- Surface water quality
- Surface water quantity
- Groundwater quality
- Groundwater quantity
- Available Water by Basin
- Present Water Use
- Water Law
- Springs
- Floods
- Sediment
- Salinity
- Subsidence
- Computer Models
- Climate

The remaining twelve topical bibliographies are not regionally specific, but deal with oil shale processes and broad topical categories:

- Surface retort effluents
- Surface retort leaching
- Surface retort water use
- Surface retort reclamation
- Environmental studies
- Bibliographies
- In-situ retort effluents
- In-situ retort leaching
- In-situ retort water use
- In-situ retort reclamation
- Computer models
- Proceedings

An expanded definition of each key-word category is contained in Appendix A and the Topical Bibliographies volume.

CHAPTER 2

DATA COMPILATION

INTRODUCTION

Hydrologic and climatologic data have been compiled using both published and unpublished sources for nearly 3,000 sites. Although the data are available from many diverse sources, it was found that a large portion of the data could be obtained from five computerized data bases. The actual data itself was not collected in most cases, rather; the source, the location of the data sampling or monitoring site, and the parameters sampled are reported. The Data Compilation volumes contain data on both active and inactive monitoring sites as well as one time "grab" sample sites. The majority of the monitoring sites began in the 1970's, although the Data Compilation volumes contain sites that have been continuously collecting data since 1900, and stations that only began reporting data in March 1982

The Data Compilation volumes were designed to be used on their own and in coordination with the Data Maps. Data availability may be determined for any of 11 major categories in any of the four oil shale basins by searching the appropriate data compilation volumes or for a specific geographic area by using the Data Maps to determine specific sites in the desired area. The following sections describe the organization and use of the Data Compilation volumes in conjunction with the Data Maps, and the methodology used in assembling these volumes. A detailed description of the Data Maps may be found in Chapter 3.

ORGANIZATION

Hydrologic and climatologic data sites are organized in four

volumes corresponding to the four oil shale basins (Exhibit 1). Each volume is divided into 10 categories as follows:

1. Surface water quantity
2. Surface water quality
3. Sediment
4. Wells
5. Groundwater quality
6. Areal extent of major aquifers
7. Climate
8. Flood plains
9. Present water use
10. Water available by basin

The Process Water Use Category assembles estimates of water use for surface and in-situ processes and has been compiled separately in Volume 12. This is due both to the large quantity of data and the fact that the data are not site specific.

Available data parameters for each of the 3000 data sites are recorded on Data Compilation Forms which are generally unique to that data category and sources. Due to the wide availability on computerized data bases of surface and groundwater data, these data sites were recorded in the available computer output format. Within each data source, for ground and surface water, each site received a unique number followed by a letter denoting the source. The letter codes are explained below:

Letter Code	DATA SOURCE
A	Colorado State Engineers Office Record of Registered Wells
B	Wyoming State Engineer's, Well Study
C	National Water Data Exchange's (NAWDEX) Master Water Data Index (MWDI)
D	Wyoming Water Resources Research Institute (WRRI)
E	Environmental Protection Agency's storage and retrieval system (STORET)
F	Potential Oil Shale Development Sites

Twenty six maps were compiled to display the data sites for each of the four basins at a scale of 1/2 inch to 1 mile. The Utah map is divided into four sections because of the large extent of the area. Each Data Map contains a specific type of site, as described below:

- Surface Water (Streamflow and Surface Water Quality)
- Sediment
- Groundwater (Well, Spring Discharge, and Groundwater Quality)
- Climate

There are only twenty six maps instead of twenty eight maps because two sections in Utah have no sediment sites.

EXPLANATION OF DATA CATEGORIES AND SAMPLE ENTRIES

This section will provide an explanation of each of the 10 principle categories of information listed on the previous page. Where appropriate a sample entry is described in detail from each data

source. The entries from computerized data bases contain a large amount of encoded information. A complete definition of the codes may be found in Appendix B. Exhibit 2 shows the portion of the area in Colorado study area from which example entries are drawn for discussion and explanation in the following pages. This area is taken from the north - central portion of the Colorado oil shale study area, and constitutes about 10% of the area mapped in Colorado. For data sources unique to Wyoming, Exhibit 3 serves the same function. All of the sources and data are amply illustrated by examples taken from the Colorado and Wyoming areas, so no portion of the Utah maps are presented here.

1. Surface Water Quantity

Site 43C has been selected as an example from the Colorado sample area. Each data site has information on two consecutive pages in this compilation. The printout from site 43C has been reproduced below:

EXAMPLE FROM DATA SOURCE C

```
        OR-
        GAN-
Page 1  IZA-                                                                                  TYPE   SW     SW
        TION  ORGANIZATION                                       LATI-   LONGI-  ST-  COU  OF   BEGIN   END   DRAINAGE
        CODE  STATION NUMBER    STATION NAME AND LOCATION        TUDE     TUDE   ATE  NTY  SITE  YEAR   YEAR    AREA

        USGS      43 09306222 PICEANCE CREEK AT WHITE RIVER, CO. 400439 1081408  008  103  SW    1963           652.00
                  ↑
                  └──────────────────MAP#
        OR-
        GAN-               COM-
Page 2  IZA-                PL-              SOURCE
        TION  ORGANIZATION  ETE  PEAK  LOW    FILE
        CODE STATION NUMBER FLOW FLOW  FLOW    ID

        USGS        09306222 1    E             SW
```

Site 43C is USGS station 09306222, Piceance Creek at White River, Co. It is located at 40° 04' 39" latitude and 108° 14' 08" longitude. The state and county codes, decoded in Appendix B part III, indicates that the site is in Rio Blanco County, Colorado. The

COLORADO SAMPLE MAP

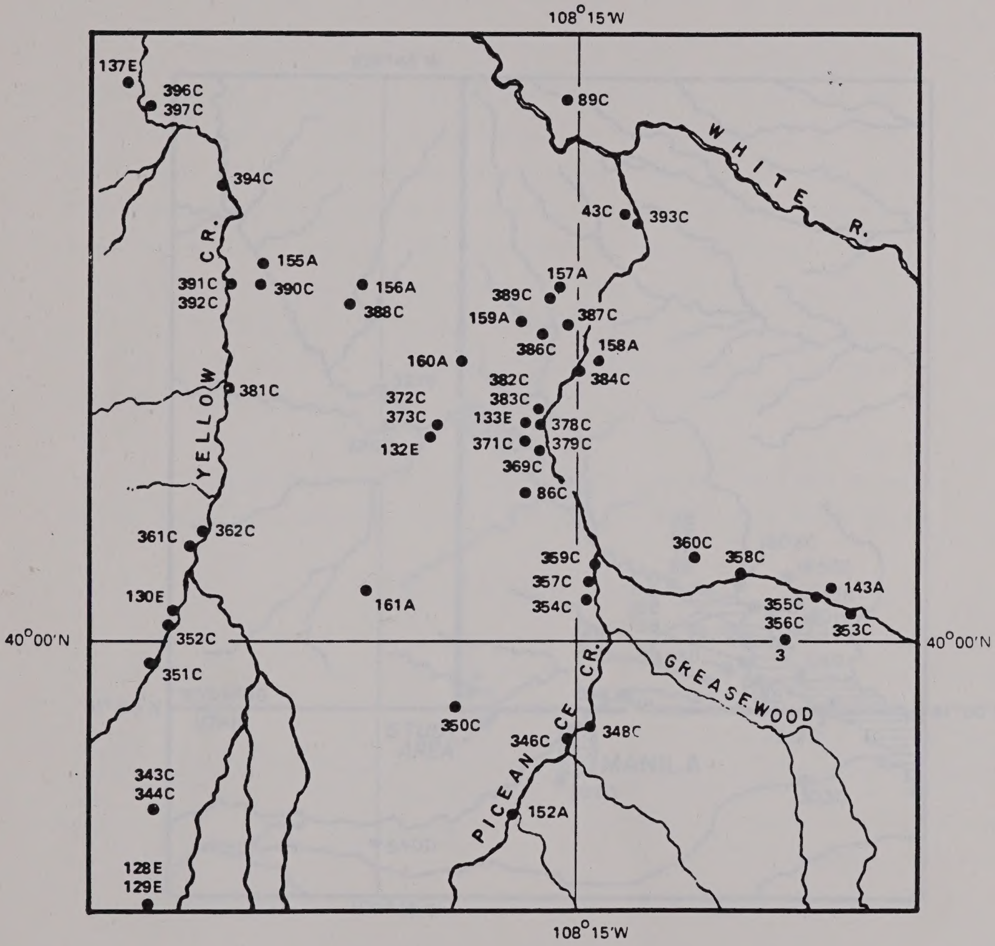

108°15'W
137E
396C
397C
89C
WHITE R.
394C
43C
393C
YELLOW CR.
155A
391C
392C
390C
156A
388C
157A
389C
159A
387C
386C
158A
160A
384C
381C
382C
383C
372C
373C
133E
378C
379C
371C
132E
369C
86C
361C
362C
360C
358C
359C
357C
143A
130E
161A
354C
355C
356C
353C
40°00'N
352C
3
40°00'N
351C
GREASEWOOD
350C
348C
346C
PICEANCE CR.
343C
344C
152A
128E
129E
108°15'W

EXHIBIT 2

WYOMING SAMPLE MAP

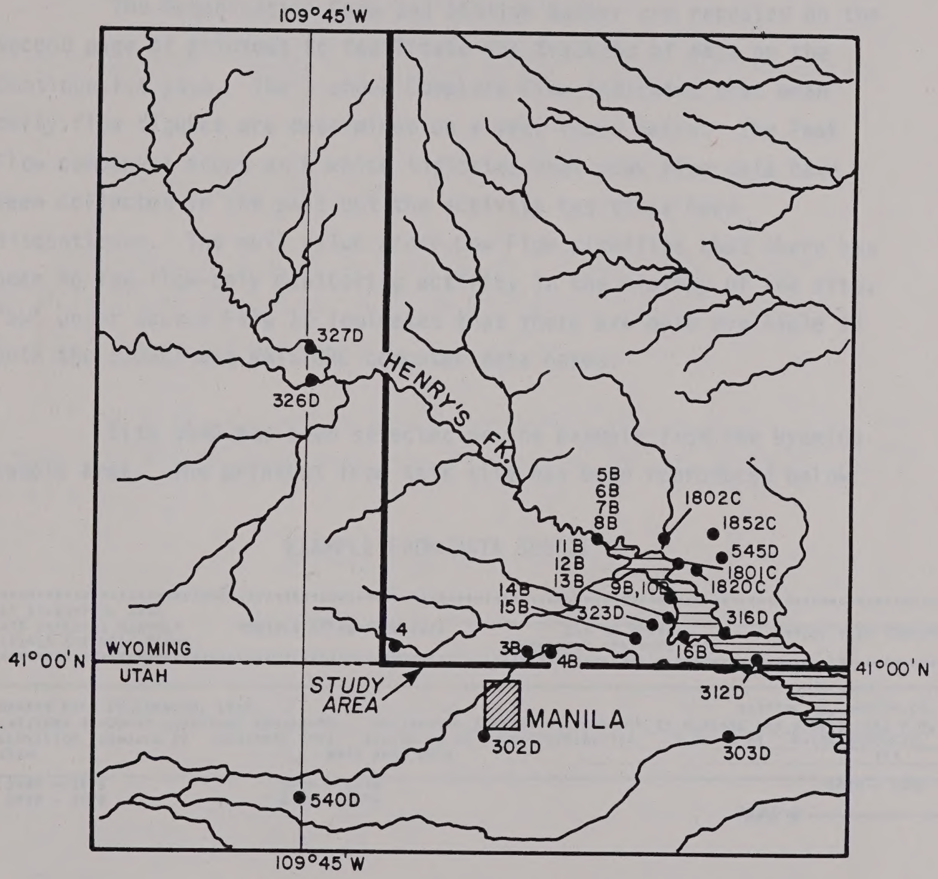

109°45'W
327D
326D
HENRY'S FK.
5B
6B
7B
8B
1802C
1852C
545D
11B
12B
13B
1801C
1820C
9B,10B
14B
15B
323D
316D
4
16B
WYOMING
41°00'N
3B
4B
41°00'N
UTAH
STUDY AREA
312D
MANILA
302D
303D
540D
109°45'W

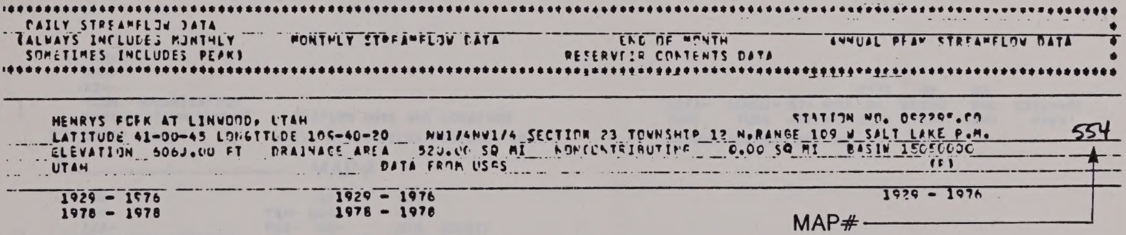
EXHIBIT 3

"SW" under Type of Site indicates that the site is on a stream. Data collection was begun at the site in 1963 and is currently collecting data as is shown under SW Begin Year and the absence of a year under SW End Year. There are 652.0 square miles in the drainage area.

The Organization Code and Station Number are repeated on the second page of printout to facilitate the tracking of data on the continuation page. The 1 under Complete Flow indicates that mean daily flow figures are determined on a year round basis. The Peak Flow component shows an E which indicates that peak flow data have been collected in the past but the activity has since been discontinued. The null value under Low Flow signifies that there has been no low-flow-only monitoring activity in the history of the site. "SW" under Source File ID indicates that there are data available in both the STORET and WATSTORE computer data bases.

Site 554D has been selected as the example from the Wyoming sample area. The printout from this site has been reproduced below:

EXAMPLE FROM DATA SOURCE D



```
*************************************************************************************************************
 DAILY STREAMFLOW DATA                                                                                       *
(ALWAYS INCLUDES MONTHLY      MONTHLY STREAMFLOW DATA            END OF MONTH            ANNUAL PEAK STREAMFLOW DATA   *
 SOMETIMES INCLUDES PEAK)                                   RESERVOIR CONTENTS DATA                          *
*************************************************************************************************************

     HENRYS FORK AT LINWOOD, UTAH                                                 STATION NO. 092295.00
     LATITUDE 41-00-45 LONGITUDE 109-40-20   NW1/4NW1/4 SECTION 23 TOWNSHIP 12 N,RANGE 109 W SALT LAKE P.M.
     ELEVATION  6060.00 FT   DRAINAGE AREA   520.00 SQ MI   NONCONTRIBUTING   0.00 SQ MI   BASIN 15050000
     UTAH                                DATA FROM USGS                                            (F)

      1929 - 1976                      1929 - 1976                                        1929 - 1976
      1978 - 1978                      1978 - 1978
```

This site is on Henrys Fork at Linwood, Utah according to the printout description. However, it is just inside the Wyoming border. It is station number 092295 at latitude 41° 00' 45", longitude 109° 40' 20" in the northwest quarter of the northwest quarter of Section 23, Township 12 North, Range 109 West from the Salt Lake Prime Meridian. The site is at an elevation of 6060 feet and has a drainage

area of 520 square miles. There is no noncontributing portion of the drainage area. The USGS Basin number is 15050000. In place of the county name, Utah appears in the printout. However, the station is actually in Sweetwater County, Wyoming. The data originated from the USGS and are publically available.

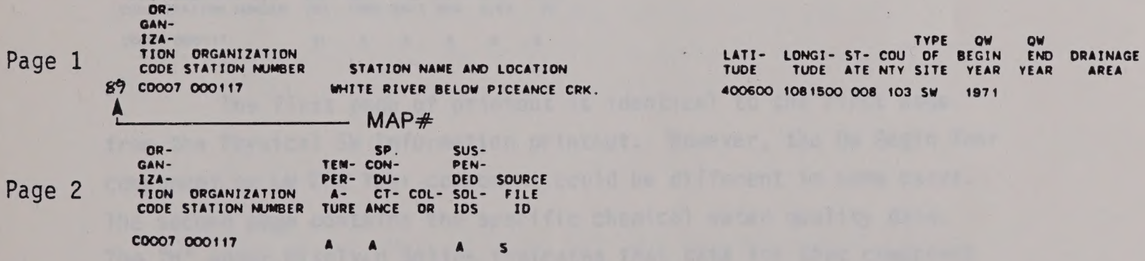
Daily and monthly Steamflow data are available for years 1929 to 1976 and 1978. Annual Peak Steamflow data are available from 1929 to 1976.

2. Surface Water Quality

Surface water quality is reported in the MWDI in two places, Physical SW Information and Chemical SW Information, an example from each will be discussed.

Site 89C has been chosen as the sample site from the Colorado sample area and is reproduced from the Physical SW Info printout and shown below:

EXAMPLE FROM DATA SOURCE C



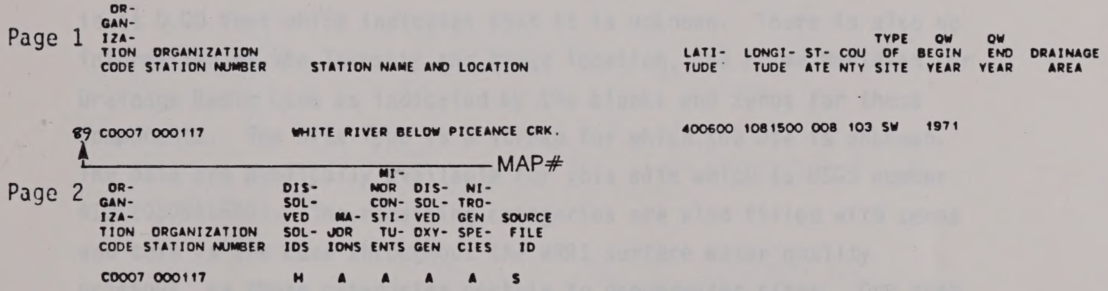
```
        OR-
        GAN-
        IZA-                                                                              TYPE   QW     QW
Page 1  TION  ORGANIZATION                                          LATI-  LONGI- ST- COU  OF   BEGIN   END  DRAINAGE
        CODE STATION NUMBER    STATION NAME AND LOCATION            TUDE    TUDE  ATE NTY SITE  YEAR   YEAR    AREA
     89 C0007 000117          WHITE RIVER BELOW PICEANCE CRK.       400600 1081500 008 103 SW   1971
      ^
      |_______________________ MAP#
        OR-                       SP.      SUS-
        GAN-                 TEM- CON-     PEN-
        IZA-                 PER- DU-      DED  SOURCE
Page 2  TION  ORGANIZATION    A-   CT- COL- SOL-  FILE
        CODE STATION NUMBER  TURE ANCE  OR  IDS    ID

        C0007 000117          A    A        A     S
```

Site 89 is Colorado State Health Department Station 000117, White River below Piceance Creek. It is at latitude 40° 06' 00", longitude 108° 15' 00". The fact that 00 seconds are shown in both the latitude and longitute probably indicates that the seconds have

been rounded off and that if the NAWDEX plotting routine is used, this station will not fall directly on the White River. The site is in Rio Blanco County, Colorado and is on a stream. Data collection began in 1971 and is continuing. The drainage area has not been reported for this site.

The second page of the printout displays the specific physical surface water quality data. The "A" under the Temperature, Specific Conductance, and the Suspended Solids components indicates that the data are collected annually. No value under Color significies that no data are collected for that component. The "S" under Source File ID indicates that the actual data are contained on the STORET data base.

Site 89C is also used as the example for Chemical SW Information and is shown from that portion of the printout below:

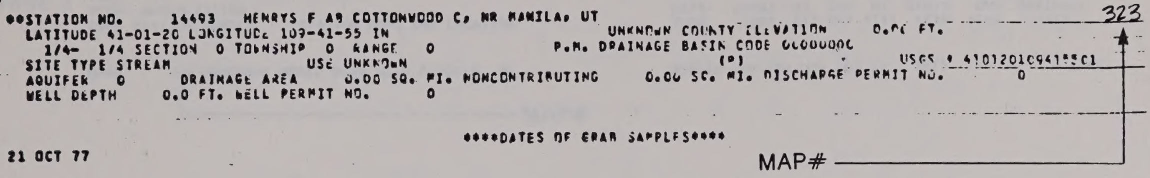


```
        OR-
        GAN-
Page 1  IZA-                                                                             TYPE   QW     QW
        TION  ORGANIZATION                                     LATI-  LONGI- ST- COU  OF   BEGIN   END  DRAINAGE
        CODE STATION NUMBER      STATION NAME AND LOCATION     TUDE    TUDE  ATE NTY SITE  YEAR   YEAR    AREA

      89 C0007 000117          WHITE RIVER BELOW PICEANCE CRK.  400600 1081500 008 103 SW    1971
      ^
      |_______________________________________________ MAP#
                                            MI-
Page 2   OR-                       DIS-     NOR  DIS-  NI-
        GAN-                       SOL-     CON- SOL-  TRO-
        IZA-                       VED  MA- STI- VED   GEN  SOURCE
        TION  ORGANIZATION         SOL- JOR  TU- OXY-  SPE-  FILE
        CODE STATION NUMBER        IDS  IONS ENTS GEN  CIES   ID

        C0007 000117                H    A    A    A    A    S
```

The first page of printout is identical to the first page from the Physical SW Information printout. However, the QW Begin Year component or QW End Year component could be different in some cases. The second page contains the specific chemical water quality data. The "H" under Disolved Solids indicates that data for that component are collected bi-monthly. Annual data are collected for Major Ions, Minor Constitutents, Dissolved Oxygen, and Nitrogen Species. The Source File ID indicates that the actual data are available on STORET.

Site 323D has been chosen as an example from the Wyoming sample area. The printout from this site has been reproduced below:

EXAMPLE FROM DATA SOURCE D



```
**STATION NO.      14493   HENRYS F AB COTTONWOOD C, NR MANILA, UT
  LATITUDE 41-01-20 LONGITUDE 109-41-55 IN                          UNKNOWN COUNTY ELEVATION     0.00 FT.
    1/4-  1/4 SECTION  0 TOWNSHIP  0  RANGE   0               P.M. DRAINAGE BASIN CODE 00000000
  SITE TYPE STREAM                USE UNKNOWN                                  (P)                 USGS # 410120109415501
  AQUIFER   0       DRAINAGE AREA      0.00 SQ. MI. NONCONTRIBUTING      0.00 SQ. MI. DISCHARGE PERMIT NO.          0
  WELL DEPTH     0.0 FT. WELL PERMIT NO.        0

                                                  ****DATES OF GRAB SAMPLES****
21 OCT 77
```

323

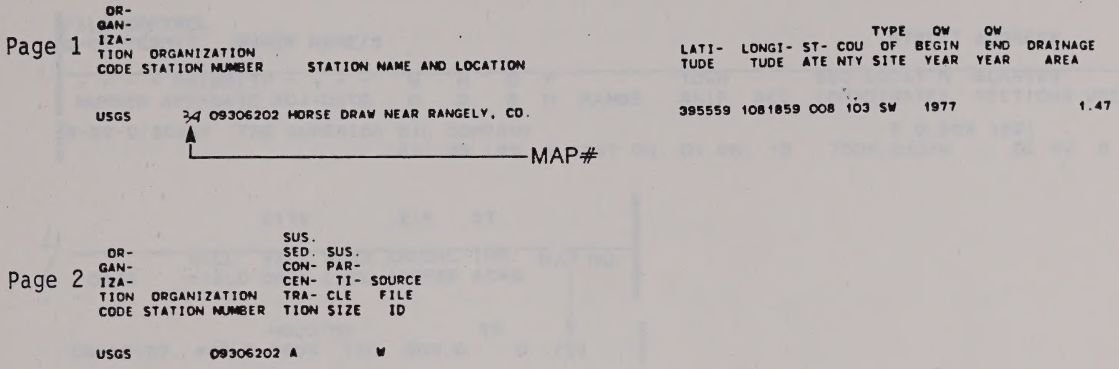
MAP#

This site is station number 14493, Henrys Fork above Cottonwood Creek, Near Manila, Utah. It is at latitude 41° 01' 20", longitude 109° 41' 55". The county is listed as unknown in the printout. However, it is Sweetwater County, Wyoming. The elevation is at 0.00 feet which indicates that it is unknown. There is also no information on the Township and Range location, the Prime Meridian, or Drainage Basin Code as indicated by the blanks and zeros for these components. The Site Type is a stream for which the Use is unknown. The data are publically available for this site which is USGS number 410120109415501. The remaining categories are also filled with zeros and this is the case throughout the WRRI surface water quality printout, as these categories pertain to groundwater sites. One grab sample was taken at this site on October 21, 1977.

3. Sediment

Site 34C has been selected from the Colorado sample area as an example and is reproduced from the printout below:

EXAMPLE FROM DATA SOURCE C



```
        OR-
        GAN-                                                                                     TYPE    QW     QW
Page 1  IZA-                                                     LATI-  LONGI- ST- COU  OF   BEGIN   END   DRAINAGE
        TION  ORGANIZATION                                       TUDE    TUDE  ATE NTY SITE   YEAR   YEAR    AREA
        CODE STATION NUMBER      STATION NAME AND LOCATION

        USGS      34 09306202 HORSE DRAW NEAR RANGELY, CO.       395559 1081859 008 103 SW    1977              1.47
                  ▲
                  └───────────────────────────MAP#


                              SUS.
        OR-                   SED.  SUS.
        GAN-                  CON-  PAR-
Page 2  IZA-                  CEN-   TI- SOURCE
        TION  ORGANIZATION    TRA-  CLE    FILE
        CODE STATION NUMBER   TION  SIZE    ID

        USGS        09306202 A           W
```

Site 34C is USGS station 09306202, Horse Draw near Rangely, Colorado. It is at latitude 39^0 55' 59" and longitude 108^0 18' 59" in Rio Blanco County, Colorado. It is a stream site that began taking measurements in 1977 and is currently active. The drainage area above the site is 1.47 square miles.

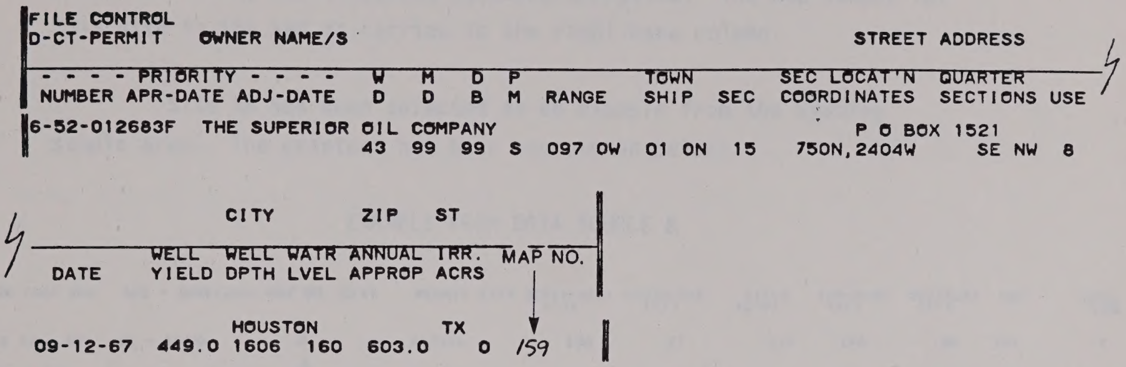
It is indicated on the second page that Suspended Sediment Concentration data are collected annually. The absence of any value under Suspended Particle Size indicates that no data ever have been collected for that site. The "W" under Source File ID signifies that the data can be obtained from WATSTORE.

4. <u>Wells</u>

Site 159A has been chosen as an example from the Colorado

sample area and is reproduced from the printout below:

EXAMPLE FROM DATA SOURCE A



```
FILE CONTROL
D-CT-PERMIT    OWNER NAME/S                                                    STREET ADDRESS
- - - - PRIORITY - - - -     W    M    D   P              TOWN          SEC LOCAT'N   QUARTER
NUMBER APR-DATE ADJ-DATE     D    D    B   M   RANGE      SHIP   SEC    COORDINATES   SECTIONS USE
6-52-012683F  THE SUPERIOR OIL COMPANY                                                P O BOX 1521
                             43   99   99  S   097 OW     01 ON  15     750N,2404W       SE NW   8

                  CITY          ZIP   ST
          WELL  WELL WATR ANNUAL IRR.   MAP NO.
 DATE     YIELD DPTH LVEL APPROP ACRS

                  HOUSTON             TX
09-12-67  449.0 1606  160  603.0    0   /59
```

Site 159A is File Control water division 6 - court number 52 Permit-012683F, owned by the Superior Oil Company, P.O. Box 1521, Houston, Texas. This information is contained on the first line of the printout while line 2 contains the data. The site is in Water District 52, Water Division 6 as indicated by the first two segments of the permit number. The remainder of the code is the actual permit number assigned to this well. The "F" indicates that this is a large capacity well. The well is in former Water District 43. There is no applicable information on the Management District or Designated Groundwater Basin for this site or any of the sites in the Colorado study area as signified by the "99" under MD and DB. The site is off the Sixth Prime Meridian as signified by the "S" under PM. The location of the well is Range 97 West, Township 1 North, Section 15. The Section Location Coordinates are 750 feet south of the north section line, and 2404 feet east of the west section line. The well is located in the southeast quarter of the northwest quarter section. The well was permitted and a statement of beneficial use submitted on

September 12, 1967. The well's yield is 449 gallons per minute. It was drilled to a depth of 1606 feet with a standing water level of 160 feet from the surface. The annual appropriation for this well is 603.0 acre-feet, and there are no acres irrigated. The map number for this site is 159 and is carried in the right hand column.

Site 4B has been selected as an example from the Wyoming sample area. The printout has been reproduced below:

EXAMPLE FROM DATA SOURCE B

```
ID TNSP RNG   SEC - QUAR/QUAR MAP NO.  CERT    PERMIT STAT DEPTH-WELL DEPTH-SWL   YIELD   TOP-MWBZ  BOT-MWBZ  USE       WELL
                                                              (FT)       (FT)     (GPM)     (FT)      (FT)              LOG

R 12   109   21 - SW/SW          4             P1736W          150        27        2.8      140         60    CUL         Y
                                 ↑
MAP# ────────────────────────────┘
```

This well has been resurveyed as indicated by the "R" under the ID component. It is the southwest quarter of the southwest quarter of Section 21, Township 12 North, Range 109 West. It does not have a Certificate/Order Record and has Permit number P1763W. The status is currently unadjudicated. The depth of the well is 150 feet with a static water depth of 27 feet. The yield of this well is 2.8 gallons per minute. The depth to the top of the main water bearing zone is 140 feet. The printout shows the depth to the bottom of the main water bearing zone as 60 feet which is in error; the real depth is most probably 160 feet. The water is used for culinary purposes and a well log is available.

5. Groundwater Quality

Groundwater quality is reported in the MWDI in two places, Physical GW Information and Chemical GW Information. An example from each will be discussed.

Site 389C has been chosen for the example from the Colorado sample area and is reproduced from the Physical GW Information printout below:

EXAMPLE FROM DATA SOURCE C

```
        OR-
        GAN-                                                                                                  PRINCI-
        IZA-                                                                         TYPE   QW      QW              PAL
Page 1  TION  ORGANIZATION                                      LATI-  LONGI- ST- COU  OF   BEGIN   END   WELL  AQUIFER
        CODE STATION NUMBER     STATION NAME AND LOCATION       TUDE    TUDE  ATE NTY SITE  YEAR   YEAR  DEPTH   CODE

    389 USGS  400353108152000 CH-3-PC, SUPERIOR OIL COMPANY      400353 1081520 008 103 GW   1968   1968
     ^
     |_________________________________________ MAP#


        OR-                          SP.          SUS-
        GAN-                   TEM-  CON-         PEN-
Page 2  IZA-                   PER-  DU-          DED   SOURCE
        TION  ORGANIZATION      A-   CT-   COL-   SOL-   FILE
        CODE STATION NUMBER   TURE  ANCE   OR    IDS     ID

        USGS  400353108152000  A     A                   S
```

This is USGS site 400353108152000, named CH-3-PC, Superior Oil Company. Note that in this case the latitude and longitude, 40° 03' 53", 108° 15' 20" are the first 14 characters of the Organization Station Number. This is true of most USGS stations in this study. The site is located in Rio Blanco County, Colorado and is a well. Data was collected only during 1968. There is no information available for Well Depth or Principle Aquifer Code for this well.

The specific physical groundwater parameters measured are shown on the second page of the printout. Temperature and Specific Conductance were collected annually, or in this case only once. Color and Suspended Solids data were not collected. The "S" under the Source File ID signifies that the data can be obtained from STORET.

Site 389C is also used as the example for Chemical GW Information and is shown from the portion of the printout below:

```
         OR-                                                                                                        PRINCI-
         GAN-                                                                                                          PAL
         IZA-                                                                      TYPE   QW     QW                AQUIFER
Page 1   TION  ORGANIZATION                                  LATI-  LONGI- ST- COU   OF  BEGIN   END   WELL       CODE
         CODE STATION NUMBER    STATION NAME AND LOCATION    TUDE    TUDE ATE NTY SITE   YEAR  YEAR  DEPTH

     389 USGS  400353108152000 CH-3-PC. SUPERIOR OIL COMPANY  400353 1081520 008 103 GW    1968   1968
      ↑
      └──────────────────────────────────── MAP#
```

```
                                       MI-
         OR-                 DIS-      NOR  DIS-  NI-
         GAN-                SOL-      CON- SOL-  TRO-
Page 2   IZA-                VED   MA- STI- VED   GEN   SOURCE
         TION  ORGANIZATION  SOL-  JOR  TU- OXY-  SPE-   FILE
         CODE STATION NUMBER IDS   IONS ENTS GEN  CIES    ID

         USGS  400353108152000 A     A    A          A     S
```

The first page of printout is identical to the first page from the Physical Information printout, However, the QW Begin Year component or the QW End year component could be different in some cases. The second page contains the specific chemical groundwater quality data. Dissolved Solids, Major Ions, Minor Constituents, and Nitrogen Species were collected annually. No Dissolved Oxygen Data were collected. The data may be obtained from STORET.

Site 453D was selected as an example from the sample area delineated in Exhibit 3 and the printout from this site is reproduced below:

EXAMPLE FROM DATA SOURCE D

```
**STATION NO.      14644    14-108-25CAB
  LATITUDE 41-09-50 LONGITUDE 109-32-10 IN                          UNKNOWN COUNTY ELEVATION        0.00 FT.                453
    1/4-  1/4 SECTION  0 TOWNSHIP  0  RANGE    0                  P.P. DRAINAGE BASIN CODE 00000000                          ↑
. SITE TYPE WELL                     USE UNKNOWN                                  (P)                      USGS + 410950109321000 |
  AQUIFER   0        DRAINAGE AREA      0.00 SQ. MI. NONCONTRIBUTING       0.00 SQ. MI. DISCHARGE PERMIT NO.        0        |
  WELL DEPTH     0.0 FT. WELL PERMIT NO.        0                                                                            |
                                                                                              MAP# ──────────────────────────┘
                                                        ****DATES OF GRAB SAMPLES****
 15 APR 71   15 APR 71   30 JUL 71   30 JUL 71   30 JUL 71   19 OCT 71   19 OCT 71   19 OCT 71   27 APR 72   27 APR 72
 30 AUG 72   30 AUG 72
```

This site is station number 14644, named 14-108-25CAB at latitude 41° 09' 50", longitude 109° 32' 10". The county is listed as unknown on the printout. However the site is in Sweetwater County. The Elevation, Township and Range, Prime Meridian, and Drainage Basin Code components all show a zero indicating no information available. The site type is a well for which the use is unknown. The data are publically available for this site which is USGS number 410950109321000. The remaining heading information components contain zeros indicating no information is available. The dates of the grab samples are self evident and run from April 15, 1971 through August 30, 1972.

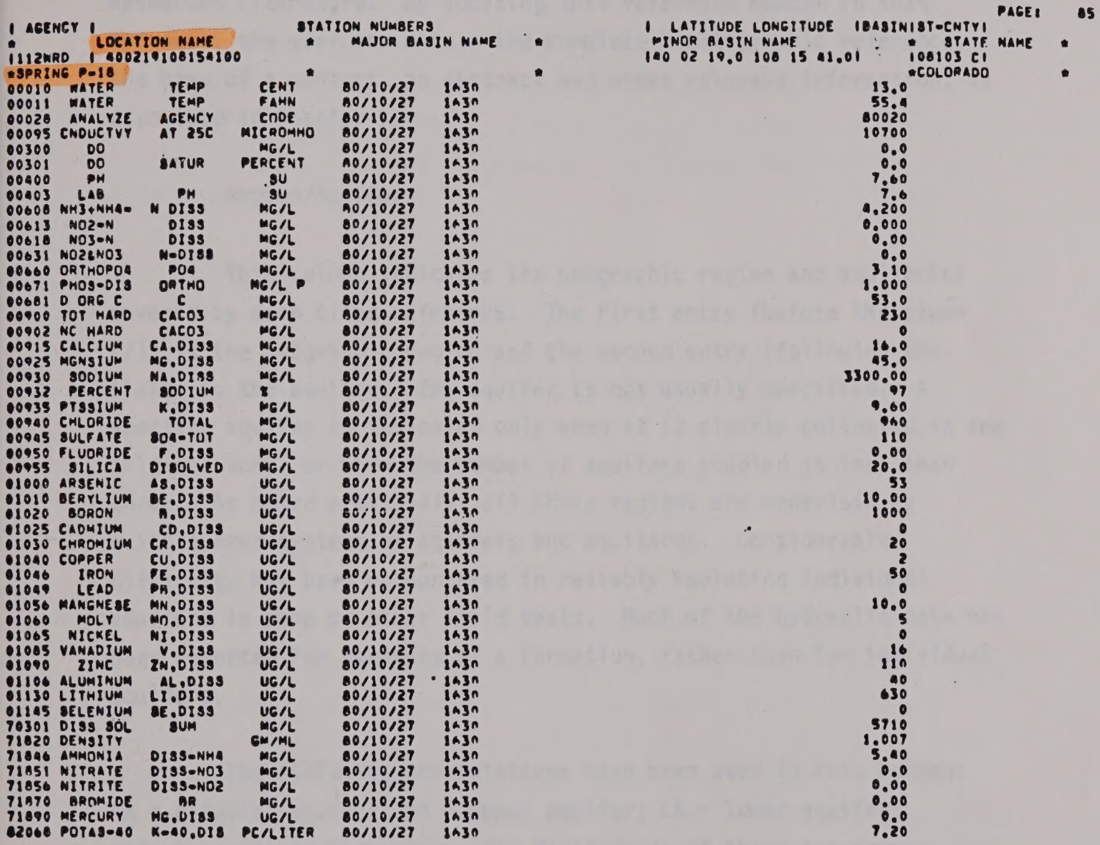
Groundwater Quality is reported in STORET by measured parameters. This printout differs from the others in that the data itself are reported.

Site 133E has been chosen for the example from the Colorado sample area in Exhibit 2 and is reproduced on the following page (Exhibit from Data Source E). The reporting agency is USGS, Station Number 400219108154100, at latitude 40° 02' 19", longitude 108° 15' 41". There is no information under the Basin component heading as this is a groundwater site, and this component is reserved for surface water sites. The state and county codes indicate that the site is in Rio Blanco County, Colorado. The location name of this site is Spring P-18. There are also no major or minor Basin Names because this is a groundwater site. The measured parameters are listed along with their units of measurement and the actual data value. All parameters were measured at 4:30 p.m. on October 27, 1980. The analyzing agency was the USGS and is the only coded parameter for this site.

6. Areal Extent of Major Aquifers

The compilation forms for areal extent of major aquifers are presented in the Data Compilation volumes. The following sections describe each major column of these compilation forms.

EXAMPLE FROM DATA SOURCE E



```
                                                                                                    PAGE:     85
| AGENCY |                              STATION NUMBERS                  |  LATITUDE LONGITUDE  |BASIN|ST-CNTY|
*            LOCATION NAME              *     MAJOR BASIN NAME      *      MINOR BASIN NAME             *    STATE NAME    *
|112WRD   | 400219108154100                                           |40 02 19.0 108 15 41.0|       |08103 C|
*SPRING P-18                            *                           *                                   *COLORADO          *
00010   WATER      TEMP      CENT       80/10/27    1430                                  13.0
00011   WATER      TEMP      FAHN       80/10/27    1430                                  55.4
00028  ANALYZE   AGENCY      CODE       80/10/27    1430                                 80020
00095 CNDUCTVY   AT 25C    MICROMHO     80/10/27    1430                                 10700
00300     DO                 MG/L       80/10/27    1430                                   0.0
00301     DO      SATUR    PERCENT      80/10/27    1430                                   0.0
00400     PH                 .SU        80/10/27    1430                                  7.60
00403    LAB        PH        SU        80/10/27    1430                                   7.6
00608 NH3+NH4-   N DISS      MG/L       80/10/27    1430                                 4.200
00613  NO2-N      DISS       MG/L       80/10/27    1430                                 0.000
00618  NO3-N      DISS       MG/L       80/10/27    1430                                  0.00
00631 NO2&NO3    N-DISS      MG/L       80/10/27    1430                                   0.0
00660 ORTHOPO4     PO4       MG/L       80/10/27    1430                                  3.10
00671 PHOS-DIS   ORTHO      MG/L P      80/10/27    1430                                 1.000
00681 D ORG C      C         MG/L       80/10/27    1430                                  53.0
00900 TOT HARD   CACO3       MG/L       80/10/27    1430                                   230
00902 NC HARD    CACO3       MG/L       80/10/27    1430                                     0
00915 CALCIUM   CA.DISS      MG/L       80/10/27    1430                                  16.0
00925 MGNSIUM   MG.DISS      MG/L       80/10/27    1430                                  45.0
00930  SODIUM   NA.DISS      MG/L       80/10/27    1430                               3300.00
00932  PERCENT   SODIUM      %          80/10/27    1430                                    97
00935 PTSSIUM    K.DISS      MG/L       80/10/27    1430                                  9.60
00940 CHLORIDE    TOTAL      MG/L       80/10/27    1430                                   960
00945 SULFATE   SO4-TOT      MG/L       80/10/27    1430                                   110
00950 FLUORIDE   F.DISS      MG/L       80/10/27    1430                                  0.00
00955  SILICA   DISOLVED     MG/L       80/10/27    1430                                  20.0
01000 ARSENIC   AS.DISS      UG/L       80/10/27    1430                                    53
01010 BERYLIUM  BE.DISS      UG/L       80/10/27    1430                                 10.00
01020  BORON     B.DISS      UG/L       80/10/27    1430                                  1000
01025 CADMIUM    CD.DISS     UG/L       80/10/27    1430                                     0
01030 CHROMIUM  CR.DISS      UG/L       80/10/27    1430                                    20
01040 COPPER    CU.DISS      UG/L       80/10/27    1430                                     2
01046    IRON   FE.DISS      UG/L       80/10/27    1430                                    50
01049    LEAD   PB.DISS      UG/L       80/10/27    1430                                     0
01056 MANGNESE  MN.DISS      UG/L       80/10/27    1430                                  10.0
01060    MOLY   MO.DISS      UG/L       80/10/27    1430                                     5
01065  NICKEL   NI.DISS      UG/L       80/10/27    1430                                     0
01085 VANADIUM   V.DISS      UG/L       80/10/27    1430                                    16
01090    ZINC   ZN.DISS      UG/L       80/10/27    1430                                   110
01106 ALUMINUM   AL.DISS     UG/L       80/10/27    1430                                    40
01130 LITHIUM   LI.DISS      UG/L       80/10/27    1430                                   630
01145 SELENIUM  SE.DISS      UG/L       80/10/27    1430                                     0
70301 DISS SOL    SUM        MG/L       80/10/27    1430                                  5710
71820 DENSITY               GM/ML       80/10/27    1430                                 1.007
71846 AMMONIA   DISS-NH4     MG/L       80/10/27    1430                                  5.40
71851 NITRATE   DISS-NO3     MG/L       80/10/27    1430                                   0.0
71856 NITRITE   DISS-NO2     MG/L       80/10/27    1430                                  0.00
71870  BROMIDE     BR        MG/L       80/10/27    1430                                  0.00
71890 MERCURY   HG.DISS      UG/L       80/10/27    1430                                   0.0
82068 POTAS-40  K-40.DIS   PC/LITER     80/10/27    1430                                  7.20
```

133

Accession Number

This is the accession number from the Bibliography of Water Resources Literature. By locating this reference number in that document, the user can obtain the complete bioliographic reference, the name of a contact, an abstract and other relevant information, as described in Chapter 1.

Region/Aquifer

This column indicates the geographic region and aquifer(s) covered by each cited reference. The first entry (before the slash (/)) is the geographic region and the second entry (following the slash) is the aquifer. The aquifer is not usually specified. A specific aquifer is indicated only when it is clearly delinated in the original work, or when the number of aquifers studied is less than three. As noted previously, oil shale regions are underlain by multilayered systems of aquifers and aquitards. Considerable difficulty has been encountered in reliably isolating individual aquifers in pump or other field tests. Much of the hydraulic data has been reported for segments of a formation, rather than for individual aquifers.

The following abbreviations have been used in this column:
AA = alluvial aquifer; UA = upper aquifer; LA = lower aquifer;
GRF= Green River Formation. The first three of these are common designations for the aquifer system found in the Piceance Basin.

Water Level And/or Potentiometric Surface Data

An asterisk (*) indicates that the reference contains water level data (unconfined aquifers) or potentiometric surface data

(confined aquifers). Information included under this category includes tabular summaries of well levels or changes in well levels, well hydrographs, and water level and potentiometric surface maps.

Geometric Properties

An astreisk (*) indicates that the reference contains information on the geometric properties of each aquifer. Information included under this category includes elevations of upper and lower aquifer horizons, aquifer thicknesses, and contour maps of formation thickness.

Hydraulic Properties

The availability of data for the four principle hydraulic properties of aquifers -- storage coefficient, transmissivity, porosity, and permeability -- is indicated by the presence of an asterisk (*). The available data includes tabular summaries of properties of individual aquifers or segments of a formation and regional contour maps.

The storage coefficient, expressed as a decimal fraction of a cubic foot, is the volume of water released or taken into storage in a column of the aquifer, having a cross-sectional area of one square foot and a height equal to the full thickness of the aquifer when the head is changed one foot. The coefficient of storage is referred to as the specific yield or drainable porosity for water table conditions (unconfined aquifer).

The transmissivity is the rate of flow in gallons per day, at the prevailing water temperature, through a vertical strip of the aquifer one foot wide extending the full saturated thickness of the aquifer under a hydraulic gradient of one foot per one foot. The transmissivity equals the hydraulic conductivity times the aquifer thickness.

The porosity is the ratio of the aggregate volume of interstices in a deposit, to its total volume, expressed as a percentage. The permeability is the rate of flow of water through a cross section of one square foot under a hydraulic gradient of one foot per foot at a temperature of 60 F.

Recharge/Discharge

An asterisk (*) indicates that the reference contains information on the location of areas of recharge and discharge or quantitative estimates of recharge and discharge in the specific area.

Geology, Lithology, and Stratigraphy

An asterisk (*) in this column indicates the reference contains geohydrologic information, including core logs and geologic cross sections, which are important to delineate major aquifers and to define their properties.

Other

This column indicates the availability of other hydrologic data which are less frequently reported. The following additional types of information are coded in this column by the specified abbreviations:

Code	Meaning
HC	hydraulic conductivity
F	fracture data
C	compressibility
E	electrical resistivity logs or parameters
C	leakance
BF	base flow
SC	specific capacity

Comments

This page presents relevant notes on the data that may help the user evaluate their suitability.

7. Climate

The Climate Data Compilation is a listing, by state, of climate stations currently operating or previously operated in the four study areas. These are stations for which there has been a continuous period of data collection. The following information is included in the climate data compilation for seven climatic parameters:

- map number;
- station name and number;
- operator of station;
- beginning and ending year;
- bibliographic accession number of data.

Site 3 has been chosen for the example from the sample area in Exhibit 2 and is reproduced below.

			Accession number of data on							
Station Name/#	Operator	Begin[1]/End	Precip.	Temp.	Evap.	Wind	Snow	Soil Moisture	Solar Rad.	Remarks
Little Hills/5048	NOAA	1946/	606	606			606			

Note that climate site numbers are not followed by a letter as there is only one data compilation form for this category. Site 3 is the Little Hills Station number 5048 in Colorado. The operator is NOAA, and the beginning year for data collection is 1946.
In the case where more than one type of data is collected, the beginning year is the earliest year that data was collected and reported for any one parameter. Precipitation, temperature and snow data for Little Hills are available from one source, Climatological Data, Colorado (Accession No. 606). No data are available on evaporation, wind, soil moisture or solar radiation for this station.

Listed below is a summary of accession numbers and the type of data they contain:

605.2	Storage-gage precipitation data for remote areas. These stations are equipped with gages that require only monthly or seasonal readings and maintenance.
605.3	Hourly precipitation data. Stations are equipped with recording-type precipitation gages that produce continuous records.
606	Climatological data for each state. Data on precipitation, temperature, evaporation, wind, and snow are reported in monthly and/or seasonal tables.
607.2	Monthly normals of temperature, precipitation, and heating and cooling degree days, 1941-70.
538	Meteorological and climatologic data from the Geokinetics oil shale research facility in Eastern Utah.

8. Floodplains

The floodplains information listing is organized by state and county. There are two types of entries: reports and maps.

For references that are maps, the citation and a summary of the map information are given. For those references that are reports, included in the listing are the bibliographic accession number, citation, type of mapping done, and a summary of important data.

9. Present Water Use

The compilation forms for Present Water Use in the Colorado, Utah, and Wyoming oil shale basins are presented in the Data Compilation Volumes. The availability of data and information in the following categories is indicated by the presence of an asterisk (*) in the appropriate column:

- general information on water use
- consumptive use by agricultural, municipal, industrial, and other users
- location of present users
- location of municipal watersheds
- models and estimation procedures to predict water use or to allocate the available supplies among users

The following sections describe each major column of these compilation forms.

Accession Number

This is the accession number from the Bibliography of Water Resources Literature. By locating this reference number in that document, the user can obtain the complete bibliographic reference, the name of a contact who can supply a copy of the data, and other relevant information, as described in Chapter 1.

Region

This column indicates the geographic region covered by each cited reference. If the reference covers a basin or region that includes only a portion of an oil shale basin, that region is specified. However, if the reference covers a larger area that includes all of the oil shale basin, such as an entire state, then the

oil shale basin itself is listed in this column. Many of the consumptive use estimates are reported for the entire region specified in this column, rather than for lower-order drainage basins or individual users. This makes the transfer of these data to different geographic regions difficult.

General Information

An asterisk (*) indicates that the reference includes a qualitative discussion of water use. The types of information included in this category are: seasonal distribution of water use, discussions of factors that affect estimates of future water use, water use projections, assessments of data accuracy, and others.

Consumptive Use

The availability of consumptive use estimates for agricultural, municipal and industrial, and all other water uses in a region is indicated by the presence of an asterisk (*) in the appropriate column. As noted under "region", consumptive use estimates are often reported for a geographical region that is different from the oil shale basins.

Location of Present Users

An asterisk (*) indicates that the reference contains information on the location of present water users. Information in this category includes State water rights listings, published summaries of water rights for various stream segments, and well listings that tabulate water use, discharge, and other information. The location of all types (agricultural, stockwaters, industrial, mining, etc.) of water users is included.

all state basin (section) is listed in this column. None of the consumptive use estimates are reported for the entire region specified in this column, rather than for lower-order drainage basins or individual users. This makes the transfer of such data to different geographic regions difficult.

General Information

An asterisk (*) indicates that the reference includes a qualitative discussion of water use. The types of information included in this category are: general distribution of water use, discussions of factors that affect estimates of future water use, water use projections, assessments of data adequacy, and regional.

Consumptive Use

The availability of consumptive use estimates for agricultural, municipal and industrial, and all other water uses in a region is indicated by the presence of an asterisk (*) in the appropriate column. As noted under "Region", consumptive use estimates are often reported for a geographical region that is different from the all state basins.

Location of Present Users

An asterisk (*) indicates that the reference contains information on the location of present water users. Information in this category includes state water rights listings, published summaries of water rights for various stream segments, and well listings that indicate water use, discharge, and other information. The location of all types (agricultural, wastewater, industrial, mining, etc.) of water users is included.

Location of Municipal Watersheds

An asterisk (*) indicates that the reference contains water use data for individual municipalities, rather than aggregate municipal demand for a region.

Models and Estimation Procedures

An asterisk (*) indicates that the reference presents an estimation procedure or computer model suitable for calculating present and projected water use. This category of information includes water allocation models and procedures to calculate irrigation and domestic water use.

Comments

This page presents relevant notes on the data that may assist the user in evaluating their utility.

10. Available Water by Basin

The compilation forms for Available Water by Basin for the Colorado, Utah, and Wyoming oil shale basins are shown in the Data Compilation Volumes. The availability of data and information in the following categories is indicated by the presence of an asterisk (*) in the appropriate column:

- mean annual steamflows
- uncommitted surface water
- recoverable groundwater
- water budgets
- location of water-short areas
- water resources developments

The following sections describe each major column of these compilation forms.

Accession Number

This is the accession number from the Bibliography of Water Resources Literature. By locating this reference number in that document, the user can obtain the complete bibliographic reference, the name of a contact who can supply a copy of the data, and other relevant information, as described in Chapter 1.

Region

This column indicates the geographic region covered by each cited reference. If the reference covers a basin or region that includes only a portion of an oil shale basin, that region is specified. However, if the reference covers a larger area that includes all of the oil shale basin, such as an state, then the oil shale basin itself is listed in this column.

Mean Annual Streamflows

An asterisk (*) indicates that the reference contains tabulations of long-term mean annual streamflows or of annual streamflows at gaging stations within the Colorado, Utah, or Wyoming oil shale basins. Most of these tabulations are from other studies which used a base year or period or record which may differ from that used in EISs. Thus, these tabulations may not be useful, and it is recommended that the analytical capabilities of the computerized data bases, STORET, WATSTORE, WRRI, and others, be used to generate streamflow summaries for future studies by the BLM. Some of the references cited in this column include procedures for or actual reconstruction of missing streamflow data. These should supplement information and analyses available from the computerized data bases.

Uncommitted Surface Water

An asterisk (*) indicates that the reference contains tabulations or analyses and discussions of uncommitted streamflows in the oil shale basins.

Recoverable Groundwater

An asterisk (*) indicates that the reference contains data and information on recoverable groundwater. The following types of information are included in this category: quantitative estimates of groundwater in storage in various aquifers; areal extent of aquifers; suitability of groundwater for use, based on quality of recovery economics.

Water Budget

An asterisk (*) indicates that a water balance has been computed for the basin indicated in the "region" column. In some cases, water budgets are presented for sub-basins, and these are described in the comments column.

Location of Water-Short Areas

An asterisk (*) indicates that information on water-short areas is included in the reference.

Water Resource Developments, Existing and Proposed

An asterisk (*) indicates that the reference contains information on surface storage facilities. The following types of information are included in this category: inventories of stockponds and small reservoirs; inventories of federal and state water resource developments; U.S. Bureau of Reclamation studies and reports on

proposed water resource developments, including feasibility reports, definite plan reports, concluding reports, and reconnaissance reports; and Bureau of Land Management and other agency environmentral impact statements (EISs) on water resource developments; and pertinent background studies to reports on proposed water resource developments including flood routing studies, reservoir operation studies, and site geologic investigations. Individual categories of data included within these reports, such as mean annual streamflows, consumptive use estimates, or available surface water, are not usually individually coded on this or other compilation forms unless the data are particularly important. This category includes water resource developments within each of the four oil shale basins as well as those outside of these basins which either supply water to the basins or divert water from the basins. If the reference addresses a single water resource development, such as the USBR studies do, that development is noted following the asterisk (*).

Comment

This page presents relevant notes on the data that may assist the user in evaluating their utility.

OTHER DATA

Process Water Use

This data compilation presented in Volume 12 can be used to identify available information on water used by various oil shale processes and is reported in a separate volume. The following three-step procedure for using this compilation is recommended:

1. The processes of interest should be selected from the various columns under "Consumptive Water Use."

2. All of the references that have reported information on water use by this process(es) can be identified by moving

down the column. The type of information available in each noted reference can be determined by checking the last column on "Information Available in Appendix".

3. The Appendix then should be consulted to locate specific information. If additional information, not in the Appendix, is required, the contact should be consulted by referring to the "Listing of Personnel and Agencies," Volume 7.

The Process Water Use Appendix, is included as an extra source of information because many of the key references on process water are not readily available, and we believe that it is important that the estimation bases be understood and accessible. This Appendix contains important information on most of the principle references in the Data Compilation Volume. It consists of a compendium of tables, figures, and text that are important in clarifying the reported consumptive use estimates. Each section includes a brief description of the proposed oil shale development and important process water use information, including water flow schematics, tabulations of water use by category and discussions of water use.

Supplementary Data Sources

In some instances it may be more convenient for the user to obtain the actual data from an existing hard copy reference, as opposed to a computerized data base. Supplementary data sources are included in the Data Compilation volumes to permit the user to go to the original source of the data. Tables have been created for those data categories found on computerized data bases, to provide a brief summary of the data available from primary references. Information in the summary includes accession number, author, data, region, a brief sentence on the extent of the data coverage, and any additional comments that may be helpful.

Potential Oil Shale Development Sites

Hard copy data has also been crosstabbed by oil shale development site to enable the user to quickly determine available data at a given site. Each site has been given a number followed by the letter "F" to locate it on the Data Maps. References which contain monitored site data are listed on this table and the availability of data in a specific category is indicated by an asterisk (*) in that column. In some instances, data were not publically available at the time this document went to press (July 1982) and are indicated on the tables by the word "unknown."

BLM Library
Denver Federal Center
Bldg. 85, OC-521
P.O. Box 25047
Denver, CO 80225

CHAPTER THREE

DATA MAPS

INTRODUCTION

Data maps have been prepared to assist the user in accessing data and information. To obtain data or information on a specific geographic area, the user would first turn to the data maps. From these maps, the following types of data may be selected:

Map 1 - Surface Water (Streamflow and Surface Water Quality)

Map 2 - Sediment

Map 3 - Groundwater (Well, Spring Discharge, and Groundwater Quality)

Map 4 - Climate

A site on one of the maps will be specified by a solid circle (●) followed by the station number and possibly a letter. The station number refers to the number of the station in the Data Compilation Volumes and the letter refers to a specific Data Form within a data category if multiple Forms exist. The Climate Data Compilation has only one form and hence does not contain a letter in the station designation. The following letters refer to the following Forms:

A - Colorado State Engineer's Office Record of Registered Wells
B - Wyoming Well Study
C - NAWDEX Master Water Data Index (MWDI)
D - Wyoming Water Resources Research Institute (WRRI)
E - STORET

DATA MAPS

A series of base maps have been compiled for the four study areas shown in Figure 1. These maps have been compiled at a scale of 1/2 inch to the mile (1:126,720) from the Bureau of Land Management's "Surface Management Quad" series, which were also at a scale of 1:126,750. The following sets of coordinates have been used to define the study areas:

	Latitude	Longitude
Colorado		
	39°28'N	109°00'W
	40°07'N	109°00'W
	40°15'N	108°30'W
	40°05'N	107°50'W
	39°28'N	107°50'W
Utah		
	39°15'N	109°02'W
	39°15'N	110°05'W
	40°00'N	111°00'W
	40°48'N	111°00'W
	40°48'N	109°02'W
Wyoming I		
	41°40'N	107°35'W
	41°40'N	108°55'W
	41°00'N	108°55'W
	41°00'N	107°35'W
Wyoming II		
	41°30'N	109°15'W
	41°30'N	109°45'W
	41°00'N	109°15'W
	41°00'N	109°45'W

Colorado, Wyoming I, and Wyoming II have each been drafted on one sheet. Due to the large size of the Utah area, it was divided into four parts (A, B, C, D). The four parts overlap by a significant portion to allow for easy assembly into one large map if desired. In creating the overlap areas it was possible to divide the Utah area in

such a way as to include a complete BLM District on each of the four parts.

Stream drainage, canals, and lakes appear on the base maps along with towns, which are the only cultural feature shown. Latitude and longitude are shown by tic marks along the edges of the map and the township and range location grid is superimposed over the map. This grid is potentially confusing in areas of Utah where a survey line resulted in the reorganization of the grid. The survey line also is plotted on the base maps. A series of four overlays have been drafted to display the monitoring sites. Each overlay has been reproduced photographically with the base map to produce four sets of maps for each area. The sample areas displayed in Exhibits 2 and 3 have been reproduced using all four overlays at once on the base map. In these areas the data was sparse enough to enable this to be done. On the full area maps however, this would not be possible due to the large quantity of data to be displayed.

such a way as to include a complete BLM District on each of the four parts.

Stream drainage, canals, and lakes appear on the base maps, along with towns, which are the only cultural feature shown. Latitude and longitude are shown by tic marks along the edges of the map and the township and range location grid is superimposed over the map. This grid is potentially confusing in areas of Utah where a survey line resulted in the reorganization of the grid. The survey line also is plotted on the base maps. A series of four overlays have been drafted to display the monitoring sites. Each overlay has been reproduced photographically with the base map to produce four sets of maps for each area. The sample areas displayed in Exhibits 2 and 3 have been reproduced using all four overlays at once on the same map. In these areas the data was sparse enough to enable data to be shown. On the full area maps however, this would not be possible due to the large quantity of data to be displayed.

CHAPTER FOUR

METHODOLOGY

SOURCES

The Data Compilation volumes were compiled from an extensive search of both published and unpublished sources. Data for the surface and groundwater categories (numbers 1 through 5) were found in many diverse sources. Invariably, however, the data could also be found in one of the five computerized data bases that were searched. The approach used in this study was to first search the most comprehensive source, use that as a base source, and add to that any new information. Included in the data compilations for these topics are commented reference lists of those documents that primarily contain new or original data.

The major advantage to using computerized data bases is the ability to analyze the data, perform statistical functions, and plot the data on graphs and maps. The major analytical capabilities of the computerized data bases are summarized on Exhibit 4.

The Master Water Data Index (MWDI) was found to be the most comprehensive computerized data base, containing both STORET and WATSTORE stations. This system has the most flexible output format and is staffed by very helpful and knowledgeable people. The mapping capabilities associated with the MWDI were also found to be superior to other systems, allowing for changes in map projection as well as scale. Few other mapping systems contain this feature. Relatively few errors were discovered in their station files. However, the majority of the errors were incorrect county codes. The discovered errors were reported to NAWDEX for updating, their files.

CHAPTER FOUR

METHODOLOGY

SOURCES

The data compilation volumes were compiled from an extensive search of both published and unpublished sources. Data for the surface and groundwater categories (numbers 1 through 9) were found in many diverse sources. Invariably, however, the data could also be found in one of the five computerized databases that were searched. The approach used in this study was to first search the most comprehensive source, use that as a base source, and add to that any new information. Included in the data compilations for these topics are numbered reference lists of those documents that primarily contain raw or original data.

The major advantage to using computerized data bases is the ability to analyze the data, perform statistical functions, and plot the data on graphs and maps. The major statistical capabilities of the computerized data bases are summarized in Exhibit 6.

The Master Water Data Index (MWDI) was found to be the most comprehensive computerized data base, containing both STORET and WATSTORE stations. This system has the most flexible output format and is staffed by very helpful and knowledgeable people. The mapping capabilities associated with the MWDI were also found to be superior to other systems, allowing for changes in map projection as well as scale. Few other mapping systems contain this feature. Relatively few errors were discovered in their coverage files. However, the majority of the errors were incorrect county codes. The discovered errors were reported to NAWDEX for updating their files.

EXHIBIT 4

SUMMARY OF DATA ANALYSIS CAPABILITIES

STORET

- Transfer of USGS flow data to STORET stations
- Calculation of equivalent loads
- Assessing existing conditions in terms of standards violations
- Generation of area-shaded maps
- Illustration of historical trends using statistical summaries
- Plotting trends over time
- Generation of trend maps
- Linear regressions of concentration versus time
- Formating STORET data for input into SAS (Statistical Analysis System)

WATSTORE

- Flow duration curves
- MEAN monthly flows
- Flow frequency analysis
- Log-Pearson distribution plot
- Station mapping

WRRI

- Flow duration curves
- MEAN Monthly Flows
- Flow frequency analysis
  - Log-Pearson
  - Gumbel
  - Hazen
- Station mapping
- Calculations of equivalent loads

The STORET system seemed to be the most current of the systems we utilized. There is approximately a three to six month lag between data collection and data entry. The biggest drawback to using STORET for our purposes is the relative inflexibility of formatting the output. In order to check for data parameters collected at a site it was necessary to obtain the raw data and this resulted in an unmanageable quantity of printout being generated. In addition, data entered into the STORET system is not controlled or proofed as rigorously as it is in WATSTORE.

As of March 1982 the STORET station listing were only current through 1978 in the MWDI. This presented a problem in that STORET does not have the capability to be searched by data entry date. To obtain the STORET stations entered after 1978 a two step process was required. First, the INDEX program was run to obtain all stations within the four study areas. This listing was searched manually to obtain stations entered after 1978. Second, the station identification numbers of the post 1978 entries were entered into the ALLPARM program to retrieve the raw data for these sites.

The data on WATSTORE were found to be the most accurate of the systems examined in this study, a result of rigorous standards applied to the entry of new data. A disadvantage to this checking is that it takes longer for data to become available after collection. In addition, data may be password protected in which case it is not available to the public user.

The MWDI well depth and principle aquifer codes had not yet been implemented on the system as of March 1982. In order to obtain this information it was necessary to use WATSTORE.

The WRRI Water Resources Data System contains data for Wyoming which are frequently not found anywhere else. These unique data however are often of a partial and sporadic nature, stations that

collected data only seasonally or for a brief period of time. Still, this data could be useful in areas where other data are not available. This system contains excellent analytical programs but the data are not as accurate as in other systems. Frequent locational errors and missing information were found in this data base. In many instances, latitudes and longitudes were rounded off to the nearest 10 seconds making plotting at our 1:126,750 scale difficult. In addition, the data base for the plot coordinates is not the same as for data parameters, thus possibly introducing another source of error. Sites from WRRI were therefore plotted manually.

Few errors were found in the Colorado State Engineer's Record of Registered Wells. However, the accuracy of well locations is less than that of other systems because location is by quarter/quarter section as opposed to latitude and longitude. Also, several obsolete data categories are still carried in the system.

The information in the Wyoming State Engineer's Well Study has not yet been proofed and thus the accuracy is unknown. As in the above study, locations are by quarter/quarter section and therefore somewhat imprecise.

COMPILATIONS

The methodology used in searching for and compiling data for each of the twelve categories will be discussed in turn.

1. Surface Water Quantity

It was found that the Master Water Data Index (MWDI) of NAWDEX was the most comprehensive source for surface water quantity data. An additional data source is Wyoming Water Resources Research collected data only sporadically or for a brief period of time. Still, this data could be useful in areas where other data are not available. This system contains excellent analytical programs, but the data are not as accurate as in other systems. Frequent locational errors and missing information were found in this data base. In many instances, latitudes and longitudes were rounded off to the nearest 10 seconds making plotting at our 1:126,720 scale difficult. In addition, the data base for the plot coordinates is not the same as for data parameters, thus possibly introducing another source of error. Sites from WDSI were therefore plotted manually.

Few errors were found in the Colorado State Engineer's Record of Registered Wells. However, the accuracy of well locations is less than that of other systems because location is by quarter/quarter section as opposed to latitude and longitude. Also, several obsolete data categories are still carried in the system.

The information in the Wyoming State Engineer's Well Study has not yet been proofed and thus its accuracy is unknown. As in the above study, locations are by quarter/quarter section and therefore somewhat imprecise.

COMPILATIONS

The methodology used in searching for and compiling data for each of the twelve categories will be discussed in turn.

1. Surface Water Quantity

It was found that the Master Water Data Index (MWDI) of NAWDEX was the most comprehensive source for surface water quantity data. An additional data source is Wyoming Water Resources Research

Institute's (WRRI) computerized data retrieval system. WRRI, of course, only supplements the MWDI in Wyoming, and it is definitely a secondary source. Most of the additional data from WRRI contains incomplete or fragmented records. Virtually all streamflow data found in published and unpublished sources were found to be contained in one of these two computerized data bases.

2. Surface Water Quality

The MWDI is also used in this category as the primary data source and is divided into two sub-categories: physical surface water quality and chemical surface water quality. STORET and WATSTORE data files are both summarized in the MWDI. The MWDI is the only system found in this study to provide a summary of collected data parameters at a site without retrieving the actual data. It also allows for a neat grouping of parameters to be printed out. Other data bases provide summary data but are relatively inflexible in output format, resulting in literally ten times the bulk of the MWDI printout.

WRRI is also used in this data category as a secondary source. The actual data parameters collected at each site for surface water quality have not been reported as this would require retrieval of the data values themselves.

3. Sediment

The only comprehensive recording system for sediment data is the MWDI. Due to the size and intermittent nature of the streams in the study areas the data search resulted in relatively few stations being reported.

4. Wells

Wells in this category refer primarily to those wells producing water as opposed to monitoring or observation wells which

are listed under groundwater. The best sources of data for wells are the State Engineer's Office that oversee permitting and recording of these wells. The primary source used in Colorado is the Colorado State Engineer's Office Record of Registered Wells. The data reported on these wells are accurate, with the following exceptions. Some of the internal components (such as Water District) are out of date and are no longer used. The location of the wells are in quarter/quarter sections and are therefore relatively inaccurate. The primary source in Wyoming is the Wyoming Water Well Study. This study has reliable accurate information for all wells that have been permitted, however, some wells have been permitted and never drilled. Wells that have been permitted but not drilled have not been numbered in the Data Compilation Volumes and have not been plotted on the Data Maps.

5. Groundwater Quality

The primary source for groundwater quality information is the MWDI for the same reasons discussed under surface water quality. In this case, however, the STORET portion of the MWDI is only current through 1978. An additional STORET retrieval was initiated to search for stations entered into the system after 1978. This resulted in 137 additional stations in Colorado and none in Utah or Wyoming. To determine available water quality parameters all measured data for a site has been retrieved and is included in the Data Compilation Volumes. A secondary source of data in Wyoming is WRRI.

6. Areal Extent of Major Aquifers

The oil shale regions of Colorado, Utah, and Wyoming are underlain by a highly complex and poorly understood multilayered system of aquifers and aquitards. This system has been extensively studied in the Piceance Basin in Colorado, particularly at the federal lease tracts, C-a and C-b. Relatively less work has been conducted in the much larger Utah oil shale basin, and there is very little

information on the aquifer system in the Wyoming oil shale basins. The complexity of these systems, coupled with the relatively few hydraulic data (compared to the large areas involved), will make regional modeling studies difficult to reliably perform, and additional field data are required in all four basins.

This compilation tabulates the type of groundwater quantity information that is publically available in reports, journal articles, and files of numerous public and private organizations. The compilations focus on groundwater quantity information, and summarize the availability of data that are required to define the aquifer systems in computer modeling and other analytical studies. The tabulations include water level and potentiometric surface data, aquifer geometric properties, hydraulic properties, recharge and discharge quantities and locations, and stratigraphy. They only include principle references which contain original and new data or which present good reviews and summaries of other, hard-to-obtain information. Broad, general overviews of groundwater quantity, or qualitative discussions, are omitted. These compilations focus on oil shale regions of each basin. Coal and other mineral resources also occur in the four oil shale basins, and a large number of other-mineral-specific hydrologic investigations has been conducted in some of the oil shale basins, particularly in the coal fields of Utah, Wyoming, and Colorado. Since hydraulic properties of coal aquifers are not relevant to this work, this type of information, while abstracted and included in the Bibliography of water resource literature, is omitted from the data compilations.

The areal extent of major aquifer compilations were developed by reading and evaluating each of the references that contain groundwater quantity information. The information in each category included in the survey was evaluated for its relevance to and its accuracy, and the compilation forms were coded accordingly. Approximately 50% of the groundwater quantity references in the Topical Bibliography are included in this compilation. The 50%

information on the aquifer systems in the several oil shale basins. The complexity of these systems, coupled with the relatively few hydraulic data (compared to the large areas involved), will make regional modeling studies difficult to properly perform, and additional field data are required in all four basins.

This compilation tabulates the type of groundwater quantity information that is publically available in reports, journal articles, and files of numerous public and private organizations. The compilations focus on groundwater quantity information, and summarize the availability of data which are required to define the aquifer systems in computer modeling and other analytical studies. The tabulations include water level and potentiometric surface data, aquifer geometric properties, hydraulic properties, recharge and discharge quantities and locations, and stratigraphy. They only include principle references which contain original and new data or which present good reviews and summaries of other, hard-to-obtain information. Broad, general overviews of groundwater quantity, or qualitative discussions, are omitted. These compilations cover the oil shale regions of each basin. Coal and other mineral resources also occur in the four oil shale basins, and a large number of other-mineral-specific hydrologic investigations has been conducted in some of the oil shale basins, particularly in the coal fields of Utah, Wyoming, and Colorado. Since hydraulic properties of coal aquifers are not relevant to this work, this type of investigation, while abstracted and included in the bibliography of water resources literature, is omitted from the data compilations.

The great extent of major aquifer compilations were generated by reading and evaluating each of the references that contain groundwater quantity information. The information in each category included in the survey was evaluated for its relevance to and the accuracy, and the compilation forms were coded accordingly. Approximately 30% of the groundwater quantity references in the topical bibliography are included in this compilation. The 100 included contains 99% of the relevant information. The others either do not contain the type of groundwater information that was included in this compilation, they only contain reveiws and summaries of data from other references, or they contain qualitative discussions and no numerical data.

7. Climate

The climate data compilation consists of a listing, by state, in and around the four study areas. There are 90 total stations: 62 in Utah, 10 in Wyoming, and 18 in Colorado. For each station listed, the corresponding map number, approximate period of record and accession number of the data source are given.

The National Oceanographic and Atmospheric Administration is the principle source of numerous publications of climatic data. While other federal and state organizations may operate climate stations and collect data, this is generally in cooperation with NOAA.

Four NOAA data sources are available for the climate stations in and near the study areas. These publications provide monthly, daily or seasonal data, generally for a period of no less than five years.

Several private companies operate climate stations in the Colorado and Utah study areas. The companies are listed below:

- Rio Blanco
- Multi-Minerals
- Catherdal Bluffs
- Chevron
- Superior
- Colony
- Union
- Geokinetics

Many of the data recording devices at these sites collect hourly or even continuous data. The problem with data collected at these sites is lack of continuity in site locations. Many sites are moved 3 to 4 times per year reducing their value for climatic interpolations. This is due to the nature of climatic data capture at these sites. Most of the companies included are not interested in collecting climate data as such, but rather to augment other types of data collected at a site.

8. Floodplains

Floodplain information from federal, state, and local organizations were reviewed for each study area to determine the extent of mapping, the magnitude of flooding mapped, and other available data .

The majority of floodplain references available are from flood insurance studies of the Federal Insurance Administration (now FEMA). These reports include flood frequency discharge data, flood profiles, and boundary maps. The USGS has mapped flood-prone areas with 100-year flood boundaries but provide no water surface elevations or frequency distributions. The U.S. Army Corps of Engineers is a third source of information on floodplains from the federal government. Other sources include reports prepared by consulting firms for municipalities and documents prepared by state agencies. These other sources primarily deal with flooding in localized areas such as at a highway bridge and do not provide comprehensive information.

Information on mapping is contained only in the floodplain information compilation; reports listed are also accessible in the bibliography.

Many of the data recording devices at these sites collect hourly or more continuous data. The problem with data collection at these sites is lack of continuity in site locations. Many sites are moved 3 to 4 times per year reducing their value for synoptic interpretations. This is due to the nature of [illegible] data sources at these sites. Most of the companies involved are not interested in collecting climate data as such but rather to augment other types of data collected at a site.

B. Floodplains

Floodplain information from federal, state, and local organizations were reviewed for each study area to determine the extent of mapping, the magnitude of flooding events, and other available data.

The majority of floodplain information available are from Flood Insurance studies of the Federal Insurance Administration (FEMA FIMA). These reports include flood insurance rate maps, flood profiles, and boundary maps. The FIMA has mapped flood-prone areas with 100-year flood boundaries and has provided water surface elevations or frequency distributions. The U.S. Army Corps of Engineers is a third source of information in floodplains for the Federal government. Other sources include reports prepared by consulting firms for municipalities and reports prepared by state agencies. These other sources primarily deal with flooding in localized areas such as at a highway bridge and do not provide comprehensive information.

Information on flooding is contained only in the floodplain information compilation reports listed and also available in the bibliography.

9. Present Water Use

Water use and availability have long been controversial issues in the Upper Colorado River Basin where the Colorado, Utah, and Wyoming oil shale basins are located. As a result, local, state, federal, and private organizations have conducted many studies to define the quantity of water used for agriculture, domestic supply, industrial purposes, and other uses. The references from the Bibliography of Water Resources Literature that address various aspects of water use in these basins are listed in the Topical Bibliography on Present Water Use. This available data and information is adequate to prepare regional environmental impact statements.

Competition for water between municipal, agricultural, industrial, and oil shale uses is growing, and Colorado, Wyoming, and Utah have initiated water use inventories to resolve potential water supply problems and to help determine future water appropriations. The U.S. Geological Survey has established the National Water Use Data System (NWUDS), a computerized data file accessible through NAWDEX and is working with the states to input data.

This compilation tabulates the availability of specific types of water use data that are publically available in reports, journal articles, and files of public and other organizations. The compilations indicate the availability of information and data in the following categories: general information on water use; specific estimated of consumptive use for agriculture, municipal and industrial purposes, and others; location of present users; location of municipal watersheds; and models and estimation procedures. These tabulations only include principal references which contain original and new data or which present good reviews and summaries of other, hard-to-obtain information. Broad, general overviews or dated information is omitted, unless it provides an important historical perspective. The

principal sources of consumptive use data are state inventories and the USGS NWUDS while the principal source of information on user location is water rights listings available in the State Engineer's Offices. The other reports and data files included in the compilations generally provide interpretations of this basic data or present and apply water use estimation procedures or water allocation models.

The present water use compilations were developed by reading and evaluating each of the references listed in the Topical Bibliography on this topic. Any information or data in each category (general information, consumptive use estimates, location of users, etc.) of the survey was evaluated for its relevance and accuracy, and the compilation forms were coded accordingly.

Many of the references included in the Topical Bibliography are not included on the Present Water Use compilation forms because they do not contain information in any of the coded categories, they only contain reviews and summaries of data from other sources, or they contain outdated information or limited data.

10. Available Water by Basin

The Colorado, Utah, and Wyoming oil shale basins are located in the headwaters of the Colorado River where water use, availability, and quality have long been controversial issues of national and international concern. As a result, local, state, federal, and private organizations have evaluated and re-evaluated available water supplies for projected population growth, for new industrial developments, for expanded mining, for oil shale development, and for other anticipated uses. Many of the recent studies which have addressed water availability in these oil shale basins are listed in the Topical Bibliography on Available Water by Basin.

principal sources of consumptive use data are state inventories and the USGS WRSSS while the principal source of information on user location is water rights listings available in the State Engineer's Offices. The above reports and data files included in the compilations generally provide interpretations of the basic data or present and apply water use simulation procedures or water allocation models.

The present water use compilations were developed by reading and evaluating each of the references listed in the topical bibliography on this topic. New information or data in each category (general information, consumptive use estimates, location of users, etc.) of the survey was evaluated for its relevance and accuracy, and the compilation forms were coded accordingly.

Many of the references included in the topical bibliography are not included on the Present Water Use compilation forms because they do not contain information in any of the coded categories, they only contain reviews and summaries of data from other sources, or they contain outdated information or limited data.

10. Available Water by Basin

The Colorado, Utah, and Wyoming oil shale basins are located in the headwaters of the Colorado River where water use, availability, and quality have long been controversial issues of national and international concern. As a result, local, state, federal, and private organizations have evaluated and recently updated available water supplies for projected population growth, for new industrial developments, for expanded mining, for oil shale development, and for other anticipated uses. Most of the recent studies which have addressed water availability in terms of oil shale development are listed in the topical bibliography on Available Water by Basin.

This compilation indicates the types of water availability data that have been presented in certain principal references - including reports, journals, and files. The availability of information and data in the following categories is included: mean annual streamflows, uncommitted surface water, recoverable groundwater, water budgets, location of water-short areas, and water resources developments. These tabulations only include principal references which contain original and new data or which present good reviews and summaries of other, hard-to-obtain information. Broad, general overviews or dated information are omitted, unless they provide an important historical perspective.

The Available Water By Basin compilations were developed by reading and evaluating each of the references listed in the Topical Bibliography on this subject. Any information or data in each category (recoverable groundwater, water budget, etc.) of the survey was evaluated for its relevance and accuracy, and the compilation forms were coded accordingly. Many of the references in the Topical Bibliography are not included on the available water by basin compilation forms because they do not contain information in any of the coded categories, they only contain reviews and summaries of data from other sources, or they contain outdated information or limited data.

Our reviews of this information reveals that considerable additional study, data, and information are required on the following three topics before reliable regional environmental impact statements can be prepared: uncommitted surface water, recoverable groundwater, and water budgets. The amount of uncommitted surface water available for oil shale and other developments is still uncertain due to the complex legal framework that governs waters of the Colorado River. The quantity of recoverable groundwater is unknown in most of these basins due to a lack of basic field data. Additionally, the suitability of available groundwater for consumption, and the economics of its recovery and treatment, have not been widely

This compilation indicates the types of water availability data that have been published in certain principal references including reports, journals, and files. The availability of information and data in the following categories is included: mean annual streamflows, unappropriated surface water, recoverable groundwater, water budgets, location of water-based sites, and water resources developments. These tabulations only include principal references which contain original and new data or which present good reviews and summaries of other, hard-to-obtain information. Brief, general overviews of given information are omitted, unless they provide an important historical perspective.

The available water by basin compilations were developed by reading and evaluating each of the references listed in the topical bibliography on this subject. The information or data in each category (recoverable groundwater, water budgets, etc.) of the survey was evaluated for its relevance and accuracy, and the compilation forms were coded accordingly. Many of the references in the topical bibliography are not included on the available water by basin compilation forms because they do not contain information in any of the coded categories, they only contain reviews and summaries of data from other sources, or they contain outdated information or limited data.

Our review of this information reveals that considerable additional study, data, and information are required on the following three topics before reliable regional and general impact statements can be prepared: unappropriated surface water, recoverable groundwater, and water budgets. The amount of unappropriated surface water available for oil shale and other developments is still uncertain due to the complex legal framework that governs waters of the Colorado River. The quantity of recoverable groundwater is unknown in most of these basins due to a lack of basic field data. Additionally, the suitability of available groundwater for consumption, and the economics of its recovery and treatment, have not been widely evaluated or studied. Although a number of excellent water budgets have been computed for several regions in the study area, the absence of adequate climatic data (precipitation, evaporation) and groundwater data will limit the calculation of similar water budgets for other areas without field work.

APPENDIX A

DESCRIPTION OF KEY-WORD CATEGORIES

SITE SPECIFIC

surface water quantity

tabulations, statistical analyses and interpretations of streamflow data; hydrographs; stockponds and other storage facilities

surface water quality

tabulations, statistical analyses, and interpretations of physical and chemical water quality data

groundwater quantity

tabulations, statistical analyses, and interpretation of groundwater quantity data; base flow, aquifer properties and extent, flow velocities and direction; well listings

groundwater quality

tabulations, statistical analyses, and interpretations of groundwater quality information

water law

water law, water rights, environmental law and regulations, water politics

available water by basin

water supply, natural flows, water resource developments; USBR planning and feasibility reports are included here.

present water use

all present water uses (domestic, municipal, industrial, agricultural, mining, etc)

springs

tabulations and interpretations of water quality and quantity information for springs; includes listings of spring locations

floods

floodplains, flood statistics, flood studies

sediment

erosion, fluvial processes, physical and chemical sediment characterization

salinity

salinity of the Colorado River including assessment and control

computer models

hand, desk-top calculator, and mainframe computer analytical techniques to simulate water movement and solute transport in aquifers, streams, and spent shale piles

climate

conventional meteorological parameters, statistical analyses and tabulations

subsidence

stability of in-situ retorts and underground and surface oil shale mines

RETORTING PROCESS SPECIFIC

process water use

gross and net water requirements for oil shale processing (retorting, reclamation, dust control, cooling water, etc.)

leaching

chemical and physical characterization of leachates from surface disposal piles and abandoned in-situ retorts, kinetic and other fundamental studies

reclamation

reclamation of surface spent shale disposal piles including revegetation, irrigation, intentional leaching, pile drainage facilities, etc; abandonment of in-situ retorts including in-situ grouting, spent shale grouts, hydraulic barriers, etc.

effluents

effluent chemical and physical characterization; wastewater treatment

GENERAL

proceedings

proceedings of conferences that relate to any of the above key words

environmental

environmental assessment of all types of facilities that are located in the study area, including coal mines, pipelines, and oil shale plants; environmental monitoring plans

bibliography

compilations of references and abstracts by others on any topic included in this Table; computerized or other data bases.

APPENDIX B

EXPLANATION OF DATA COMPILATION CODES

I. Colorado State Engineer's Office Record of Registered Wells

Each entry in this printout contains two lines. The first line contains the water division number, the court number, the permit number, and name and address of the owner. The permit number is divided into three parts. The first digit is the Water Division. Water Division 5 is headquartered in Glenwood Springs, and Division 6 is headquartered in Steamboat Springs. The next two digits indicate the Water District within the Water Division, and the remaining number is the assigned permit number. An "F" or "R" indicate that the well is large capacity or a replacement well, respectively.

At the end of the first line, the abbreviation "NO SBU" may be listed. This indicates that a statement of beneficial use has not been submitted to the State Engineer's Office.

The column titles on the second line, proceeding from left to right, are explained below:

WD	indicates former Water District number used prior to reorganization into the 7 major Water Divisions.
MD	indicates the Management District, a 99 under this component signifies non-applicability.
DB	is the Designated Groundwater Basin, a 99 under this component signifies non-applicability.
PB	indicates the Prime Meridan number. All entries in the Colorado Study area contains an "S" which is the Sixth Prime Meridian.
USE	denotes the use to which the well is put

Code	Meaning
0	household only
1	domestic
2	livestock
3	domestic and livestock
4	commercial
5	industrial
6	irrigation
7	irrigation and industrial
8	municipal

DATE - is the date a statement of beneficial use was submitted, generally corresponding to the permitting date.

WELL YIELD - represents actual, estimated, or averaged yield in gallons per minute (GPM).

WELL DEPTH - the actual depth to the bottom of the well in feet

WATR LVEL - is the depth to the water level in feet

ANNUAL APPROP - is the annual appropriation in acre-feet

IRR ACRS - the actual area under irrigation in acres

MAP NO. - the number on the Data Maps, suffixed with an "A"

The third line contains the data in the appropriate columns.

II. Wyoming State Engineer's Well Study

A. ID- indicates type of survey, if any,

CODE	MEANING
R	Resurveyed
U	Unsurveyed
M	Mineral Survey
Null	Original Survey

B. Location - is by Township, Range, and Section to the nearest quarter/quarter section

ABBREVIATION	NAME
TNSP	Township
RNG	Range
SEC	Section
Quar/Quar	Quarter/Quarter Section

C. Cert/Order Record - All related records referenced on the Certificate or Order. The prefix to identify these records is listed below. Each will be followed by the book #/page # of the reference.

CODE	NAME
O	Order Record
C	Certificate Record
CR	Reservoir Certificate Record
CU	Ground Water Certificate Record
M	Minute Record
MR	Miscellaneous Record
D	Court Decree Book
CD	Certificate Dummy
OD	Order Dummy

D. Permit - This will be reflected only if the record of adjudication contained the permit number it was issued against. The prefix "P" (denoting Permit) will always precede the permit number, which shall be followed by the suffix used to identify the various permit types as listed below:

CODE	MEANING
C	Statement of Claim, completed prior to April 1, 1947.
G	Well Registration, completed between April 1, 1947 and March 1, 1958.

W	Well permit, filed after March 1, 1958.
P	Stock or Domestic (registration) permit, drilled prior to May 24, 1969; after this date converted to "W" suffix.

E. Stat - Status of the permit

CODE	MEANING
ABA	Abandoned
ADJ	Adjudicated
AME	Amended
CAN	Cancelled
EXP	Expired
REJ	Rejected
NULL	Unadjudicated

F. Depth-Well - Actual depth in feet, available only after well has been constructed. This measurement will be omitted for the permit ("W" suffix) until the Statement of Completion is received, but is shown on all other permit types.

G. Depth-SWL - Depth to the static water level by feet. Those carrying the "W" suffix shall be shown only if the well is completed.

H. Yield - Represents actual, estimated, or averaged yield in gallons per minute (GPM).

J. Top MWBZ - Depth to top of main water bearing zone.

K. Bottom MWBZ - Depth to the bottom of the main water bearing zone as interpreted from the driller's log. Information for top and bottom is available for only those permits with a "C", "G", "P" or "W" suffix that has been completed. If there is not an available driller's log, this component will reflect UNKNOWN or be omitted from the printout.

L. Use - To which well is applied

CODE	MEANING
MON	Monitoring
BAT	Bathing
CHE	Chemical
COM	Commerical
CUL	Culinary
DOM	Domestic (Residential)
DRI	Drilling
ERO	Erosion Control
FIR	Fire Protection
FIS	Fish and Wildlife
FLO	Flood Control
ICE	Ice Cutting
IND	Industrial
IRR	Irrigation
MAN	Manufacturing
MEC	Mechanical
MIL	Milling
MIN	Mining
MIS	Miscellaneous, includes silt storage, medicinal, institutational, highway rest area or unknown
MUN	Municipal
OIL	Oil Refining/Production
POW	Power Development
PRE	Preferred Use
RES	Reservoir Supply
STE	Steam Engines
STO	Stock
TEM	Temporary Use
TRA	Transportation
UTL	Public Utility
WIL	Wildlife
DEW	Dewatering

M. Well Log - Y indicates yes there is a driller's log on file.
N indicates no driller's log available.

III. NAWDEX - Master Water Data Index

The MWDI printout consists of two pages containing mostly general header information on the first page and category specific information on the second page.

A. General

1. Organization Code

Code	Name
USBR	Bureau of Reclamation
USEPA	Environmental Protection Agency
USFS	Forest Service
USFWS	Fish and Wildlife Service
USGS	Geologic Survey
USNER	National Environmental Research
CO007	Colorado State Health Department
UT001	Utah State Health Department

2. State and County Codes

Code	Name	Code	Name
008	Colorado	045	Garfield County
		013	Rio Blanco County
049	Utah	007	Carbon County
		009	Daggett County
		013	Duschesne County
		015	Emery County
		019	Grand County
		043	Summit County
		047	Uintah County
		051	Wasatch County
056	Wyoming	007	Carbon County
		037	Sweetwater County

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3. Type of Site

Code	Name	Meaning
SW	Stream	A body of water flowing in a natural channel as distinct from a canal.
LK	Lake, Reservoir	An inland body of standing water, an expanded part of a river, or an impoundment formed by a dam.
CN	Canal	An artificial waterway designed for navigation or for transporting water for municipal water supply, land irrigation, or drainage.

Code	Name	Meaning
DR	Drain	A small artificial water-course designed to drain swampy areas or irrigated lands. Theoretically it is actually a small canal, but it is referred to as a "drain" in many localities.
GW	Well	An artificial excavation that derives some water from the interstices of the rocks or soil which it penetrates, and from which water can be drawn by means of siphon.
SP	Spring	A place where water flows from a rock or soil upon the land surface or into a body of water.
SS	Specific Source	An artificial conduit or other conveyancy where pollutants are discharged (from factories, sewage treatment plants, etc.) into a water body or aquifer.
OT	Other	Other types of sites where hydrologic data not categorized above, are collected.

4. SW Begin Year - This component identifies the calendar year in which the acquisition of surface water data first began at a site, regardless of the types of surface water data that were collected. This date will never change even though surface water data collection may be deactivated and reactivated several times during a site's history.

5. GW Begin Year - Same as above, only for groundwater.

6. SW End Year - This component identifies the calendar year in which all surface water data collection activity at the site was discontinued. If at a later date, the collection of any of the surface water parameters is resumed, the former end data is deleted. If the organization is currently collecting any surface water data at the site, this component is not valued.

7. GW End Year - Same as above, only for groundwater.

8. Drainage Area - The drainage area of the stream at the specific location of the site is that area, measured in a horizontal plane, enclosed by a topographic divide from which

direct surface runoff from precipitation normally drains by gravity into the stream above the site; it includes all closed basins, or noncontributing areas, within the total drainage area. The component is not valued for groundwater stations.

9. Source File ID

Code	Name
S	STORET
W	WATSTORE
NULL	Source file ID may be obtained from NAWDEX Office

B. Category Specific

1. Streamflow - Surface water flow is the discharge that occurs in any natural or artificial surface channel or course. Discharge is the volume of water (or more broadly, total fluid) that passes a given point within a given period of time.

   a. Complete flow - Complete flow means that flow (discharge) figures are determined based upon a complete record (full range) of stage, as opposed to partial record flow where figures pertain only to a predetermined limited range in stage. Partial record flow sites are separately accounted for in peak flow and low flow.

Codes		Meaning
Year Round	Seasonal	
1	2	Daily - mean daily flow figures are determined either on a year-round basis or only during certain portions of a year, as indicated by the code entered.

3	4	Monthly - monthly totals and mean monthly flow figures are determined either on a year round basis or only during certain portions of the year, as indicated by the code entered.
	E	Eliminated activity - complete flow figures have been determined in the past, but have since been discontinued.

b. Peak flow - This component pertains primarily to those sites where less than a complete record (full range) of flow is being or has been determined. It is predominantly a type of partial record site (commonly called a crest-stage site) where peak flows (instantaneous discharges) above a predetermined base are being measured. This component and Complete Flow may both be valued if peak flow is discretely available in addition to complete flow.

Code	Meaning
1	Year round - Peak flows (instantaneous discharges) only above a predetermined base, are determined on a year round basis.
2	Seasonal - peak flows (instantaneous discharges) only above a predetermined base, are determined only during certain portions of the year.
8	Annual - same as year round (above) except that only the maximum peak for the year is recorded.
9	Not specified - peak flow data are collected at an irregular or unspecified frequency.

E	Eliminated activity - peak flow data have been collected in the past but the activity has since been discontinued. Also, applies, if the site previously measured peak flow only, or peak flow and low flow only, but now measures complete flow.
Null	A null value signifies that there has been no peak flow only, or peak flow and low flow only, activity in the history of the site.

c. Low Flow - this component pertains primarily to those sites where less than a complete record (full range) of flow is being determined. It is predominantly a type of partial record site where only low flows are being determined. This component and complete flow may both be valued if low flow is discretely available in addition to complete flow.

Code	Meaning
1	Year round - low flow determinations (machine recorded or observed) are made on year-round basis.
2	Seasonal - low flow determinations (machine recorded or observed) are made only during certain portions of the year.
9	Not specified - low flow data are collected at an irregular or unspecified frequency.
E	Eliminated activity - low flow data have been collected in the past but the activity has since been discontinued. Also applies if the site previously measured low flow only, or peak flow and low flow only, but now measures complete flow.
Null	A null value signifies that there has been no low flow only or peak flow and low flow only, activity in the history of the site.

2. Surface Water Quality - a group of components indicating the types of water quality data collection activities performed. A 1-character alphabetic code under a component indicates the frequencies at which the observations are made. See Appendix C for frequency codes.

   a. Temperature - a measure of the intensity aspect of heat energy present in a water body. It influences the aquatic environment and affects the aquatic biota, the concentrations of dissolved gases, and the distribution of chemical solutes (dissolved substances).

   b. Specific Conductance - a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25°C.

   c. Color - in water can be caused by the presence of plankton, aquatic vegetation, decaying organic matter, natural metallic ions, industrial wastes, and sewage. A distinction is made between "true color" (the color of a water sample after turbidity and sediment have been removed by filtration) and "apparent color" (the color of an untreated water sample). "True color" is usually measured by comparing the color of a water sample to that of a fixed standard. Color is expressed in terms of "color units" where one color unit is the difference in tint produced by one milligram per liter of the chloroplatinate ion.

   d. Suspended solids - include colloidal and particulate matter, such as sand, clay, finely divided organic material, bacteria, and plankton that are suspended in the water body.

e. Dissolved solids - in water consists mainly of inorganic salts and small amounts of organic matter. A general working definition of "dissolved" (as compared to suspended) solids is anything which will pass through a 0.45 micron filter.

f. Major ions - includes elements which are (or could be) in fairly high concentration in most natural waters, such as calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulfate, chloride, etc.

g. Minor constituents- other inorganic compounds not listed under major ions.

h. Dissolved oxygen - (DO) in water is expressed in milligrams per liter and the amount present reflects chemical, physical, and biological activities in the water body. It is usually increased by aeration and the photosynthetic processes of aquatic plants.

i. Nitrogen species - A component that pertains to the measurement of any of the species of the element nitrogen commonly found in water, e.g., nitrate, nitrite, ammonia, etc.

3. Sediment - is the solid particles of inorganic or organic fragmental material, usually derived from disintegrated rocks or other earth material that have been or are being transported laterally or vertically from one or more places of origin by air or water. All references to sediment in this database pertain to fluvial sediment only -- that is, sediment which is transported by, suspended in, or deposited by water.

a. Suspended sediment concentration - is the sediment mixture that is carried in suspension in the main body of the flow of a stream for appreciable lengths of time, being kept in this state by turbulence of flow or by colloidal suspension. Suspended-sediment concentration is the velocity-weighted (representative) concentration of suspended sediment in the sampled zone (taken from the water surface to a point approximately 0.3 ft. above the bed) and is usually expressed as milligrams of dry solids per liter of water-sediment mixture.

   A 1-character alphabetic code in this component indicates the frequency with which concentration determinations are made. See Appendix C for frequency codes.

b. Suspended particle size - is the diameter, usually expressed in millimeters, of a particle measured by settling, sieving, micrometric, or direct measurement methods. Particle-size data are usually expressed as a distribution showing the relative amount, in terms of percent of total weight, of a sediment sample having a specific size finer than a given size.

   A 1-character alphabetic code in this component indicates the frequency with which suspended particle-size determinations are made. See Appendix C for frequency codes.

4. Groundwater Quality - a group of components indicating the types of water quality data collection activities performed. A 1-character alphabetic code under a component indicates the frequencies at which the observations are made. See Appendix C for frequency codes.

a. Temperature - is a measure of the intensity aspect of heat energy present in a water body. It influences the aquatic environment and affects the aquatic biota, the concentrations of dissolved gases, and the distribution of chemical solutes (dissolved substances).

b. Specific Conductance - is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25°C.

c. Color - in water can be caused by the presence of plankton, aquatic vegetation, decaying organic matter, natural metallic ions, industrial wastes, and sewage. A distinction is made between "true color" (the color of a water sample after turbidity has been removed by filtration) and "apparent color" (the color of an untreated water sample). "True color" is usually measured by comparing the color of a water sample to that of a fixed standard. Color is expressed in terms of "color units" where one color unit is the difference in tint produced by one milligram per liter of the chloroplatinate ion.

d. Suspended solids - include colloidal and particulate matter, such as sand, clay, finely divided organic material, bacteria, and plankton that are suspended in the water body.

e. Dissolved solids - in water consists mainly of inorganic salts and small amounts of organic matter. A general working definition of "dissolved" (as compared to suspended) solids is anything which will pass through a 0.45 micron filter.

f. Major ions - include elements which are (or could be) in fairly high concentration in most natural waters, such as calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulphate, chloride, etc.

g. Minor constituents-other inorganic compounds not listed under major ions.

h. Dissolved oxygen - (DO) in water is expressed in milligrams per liter and the amount present reflects chemical, physical, and biological activities in the water body. It can only be increased by aeration and the photosynthetic processes of aquatic plants.

i. Nitrogen species - A component that pertains to the measurement of any of the species of the element nitrogen commonly found in water, e.g., nitrate, nitrite, ammonia, etc.

IV. Wyoming Water Resources Institute

This printout is used to supplement the MWDI station listings. For the most part the output is written in plain language using as few codes as possible.

A. Streamflow - streamflow data availability is reported under the station heading. The availability of data under each of the headings is listed by year. It is divided into three columns: Daily, Monthly, and Annually

1. Basin - The basin codes are the standard USGS eight digit codes (Appendix F).

2. (P) - This is an internal accounting code to indicate that the data are publically available. This component appears on every record in this printout

B. Water Quality - is reported for both surface water and groundwater. The availability of data are listed by the dates of the grab samples. Specific data parameters availability are not reported on this printout. To obtain that information the entire data record must be retrieved.

1. Basin - the basin codes are the standard USGS eight digit codes.

2. Aquifer - These codes specify the aquifer that is supplying water to the well. If more than one aquifer is involved, the one in the most recent formation is listed. The other aquifer is sometimes listed under comments or station description.

   The codes are those used for the U.S. Geological Survey WATSTORE computer system and are defined in Appendix D. The aquifer number is three digits which specify the Era, System, and Series of the rock unit. The aquifer alphanumeric is one to four characters which specifies the rock-stratigraphic unit with an optional fifth character which specifies a qualifying term, such as Upper, Middle, or Lower. If there are less than five alphanumeric characters, the code is left justified, blank filled.

C. Well Level - the only coded data in this section are the aquifer codes described above.

V. STORET

The STORET printout is used to supplement the NAWDEX MWDI information. MWDI is current for STORET information through 1978. Therefore, STORET was used to retrieve data for stations entered after 1978. Post 1978 stations were only found in Colorado for groundwater quality and only those codes that appear on this printout will be defined in this appendix.

The first two lines of the STORET printout contain station identifier and location information. The remaining lines for each station contain the actual data collected.

A. Agency Codes - this is the reporting agency for the site.

Code	Meaning
112WRD	U.S. Geological Survey

B. Basin Codes - there are no basin codes available for any stations in this printout.

C. ST-CNTY Codes - these are the state and county codes shown below:.

Code	Meaning
08	Colorado
045	Garfield County
103	Rio Blanco County

D. Location Name - some locations are described.

E. Major Basin Name - there are no Major Basin Names available for any stations in this printout.

F. Geologic Age Code - These codes identify the stratigraphic Era, System, and Series of rock unit and are listed in Appendix E.

G. Aquifer Name Code - coding system proposed by the American Association of Petroleum Geologists. A listing of the codes is contained in Appendix E.

H. Analyze Agency Code - This code denotes the agency responsible for the analysis of the samples.

APPENDIX C

DATA COLLECTION FREQUENCY CODES FOR NAWDEX - MWDI

CATEGORY	Year-Round	Seasonal	Eliminated*
Continuous-Recorded Instrument	I	J	L
Continuous-Nonrecorded	C	D	T
Daily	O	P	2
Weekly	W	X	3
Bi-Weekly	F	G	4
Monthly	M	N	5
Bi-monthly	H	K	6
Quarterly	Q	R	7
Semiannual (twice per year)	S		8
Annual (once per year)	A		9
Other periodic (less often than once per year	B		
Seasonal (no time period specified)		Y	
Data collected at an irregular or unspecified frequency	Z		
Unique (one-time) measurement	U		
Eliminated Activity	E		

Frequency codes indicate the intervals of time for which records of water data are available. The meanings of the codes cited in the above table are self explanatory except for "continuous." Continuous records are those which are based upon recordings of data at intervals of four hours or less (six or more times in a 24 hour period). Continuous records based upon data automatically recorded by a recording instument are associated with frequency codes "I" or "J", while continuous records based upon manually recorded observations are associated with codes "C" or "D". Data collected at intervals greater than four hours but at least once daily fall under the codes designated as "daily". Data collection intervals that actually fall between those listed above are recorded under the next longer frequency.

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* The Eliminated Frequency Codes may be used to indicate that the collection of data for a single parameter, or data component, has been discontinued at a site and that data were being collected at the frequency indicated at the time of discontinuance.

APPENDIX D

AQUIFER NUMBER

Aquifer Number and Alphanumeric
(continued)

Era, System and Series	Aquifer Number	Era, System and Series	Aquifer Number
Unknown Age	000	Middle	324
		Des Moinesian	325
Cenozoic	100	Atokan	326
Quaternary	110	Lower	327
Holocene	111	Morrowan	328
Pleistocene	112	Mississippian	330
Tertiary	120	Upper	331
Pliocene	121	Chesterian	332
Miocene	122	Meramecian	333
Oligocene	123	Lower	337
Eocene	124	Osagean	338
Paleocene	125	Kinderhookian	339
		Devonian	340
Mesozoic	200	Upper	341
Cretaceous	210	Middle	344
Upper	211	Lower	347
Gulfian	212	Silurian	350
Lower	217	Upper	351
Comanchean	218	Cayugan	352
Coahuilan	219	Middle	354
Jurassic	220	Niagaran	355
Upper	221	Lower	357
Middle	224	Alexandrian	358
Lower	227	Ordovician	360
Triassic	230	Upper	361
Upper	231	Cincinnatian	362
Middle	234	Middle	364
Lower	237	Champlainian	365
		Lower	367
Paleozoic	300	Canadian	368
Permian	310	Cambrian	370
Upper	311	Upper	371
Ochoan	312	St. Croixan	372
Guadalupian	313	Middle	374
Lower	317	Lower	377
Leonardian	318		
Wolfcampian	319	Precambrian	400
Pennsylvanian	320	Precambrian Z	410
Upper	321	Precambrian Y	420
Virgilian	322	Precambrian X	430
Missourian	323	Precambrian W	440

Appendix E

Aquifer Name and Geologic Unit Codes

COLORADO

CENOZOIC

CENOZOIC ERATHEM	100CNZC
CENOZOIC-MESOZOIC ERATHEMS	100CZMZ

QUATERNARY

QUATERNARY SYSTEM	110QRNR

HOLOCENE

ALLUVIUM,FLOOD PLAIN	111ALFP
ALLUVIUM,TERRACE	111AVMT
DUNE SAND	111DUNE
HOLOCENE SERIES	111HLCN
VALLEY-FILL DEPOSITS	111VLFL

PLEISTOCENE

GLACIAL DEPOSITS	112GLCL
PLEISTOCENE SERIES	112PLSC
SANTA FE FORMATION	112SNTF
TERRACE DEPOSITS	112TERC

TERTIARY

TERTIARY-CRETACEOUS SYSTEMS	120TRCC
TERTIARY SYSTEM	120TRTR

PLIOCENE

ALAMOSA FORMATION	121ALMS
DRY UNION FORMATION	121DRUN
NORTH PARK FORMATION	121NRPK
OGALLALA FORMATION	121OGLL
PLIOCENE-MIOCENE SERIES	121PCMC
PLIOCENE SERIES	121PLCN

MIOCENE

ARIKAREE FORMATION	122ARKR
BROWNS PARK FORMATION	122BRPK
MIOCENE SERIES	122MOCN

OLIGOCENE

BRULE FORMATION OF WHITE RIVER GROUP	123BRUL
CHADRON FORMATION OF WHITE RIVER GROUP	123CDRN
CASTLE ROCK CONGLOMERATE	123CRCK
OLIGOCENE SERIES	123OLGC
WHITE RIVER GROUP	123WRVR

Appendix E cont.

EOCENE

CUCHARA FORMATION	124CCHR
DEVILS HOLE FORMATION	124DVLH
EOCENE-PALEOCENE SERIES	124ECPC
EOCENE SERIES	124EOCN
FARASITA CONGLOMERATE	124FRST
GREEN RIVER FORMATION	124GRRV
HUERFANO FORMATION	124HRFN
INTRUSIVE ROCKS	124IRSV
SAN JOSE AND NACIMIENTO FORMATIONS,UNDIFFERENTIATED (EOCENE-PALEOCENE)	124SJNM
SAN JOSE FORMATION	124SNJS
WASATCH FORMATION	124WSTC

PALEOCENE

ANIMAS FORMATION (PALEOCENE-UPPER CRETACEOUS)	125ANMS
DENVER FORMATION	125DNVR
DAWSON FORMATION	125DWSN
KIRTLAND SHALE	125KRLD
MIDDLE PARK FORMATION	125MDPK
NACIMIENTO FORMATION	125NCMN
OJO ALAMO SANDSTONE	125OJAM
PALEOCENE SERIES	125PLCN
POISON CANYON FORMATION	125PSNC
RATON FORMATION	125RTON

MESOZOIC

MESOZOIC ERATHEM	200MSZC
MESOZOIC-PALEOZOIC ERATHEMS	200MZPZ

CRETACEOUS

CRETACEOUS SYSTEM	210CRCS
DAKOTA GROUP	210DKOT

UPPER CRETACEOUS

A SANDSTONE MEMBER OF LARAMIE FORMATION	211A
ARAPAHOE CONGLOMERATE MEMBER OF LARAMIE FORMATION	211ARPH
BRIDGE CREEK LIMESTONE MEMBER OF GREENHORN LIMESTONE	211BGCK
BLUE HILL SHALE MEMBER OF CARLILE SHALE	211BLHL
B SANDSTONE MEMBER OF LARRIMIE FORMATION	211BLRM
BENTON SHALE	211BNTN
CODELL SANDSTONE MEMBER OF CARLILE SHALE	211CDLL
CLIFF HOUSE SANDSTONE OF MESAVERDE GROUP	211CLFH
UPPER CRETACEOUS SERIES	211CRCSU
CARLILE SHALE	211CRLL
FORT HAYS LIMESTONE MEMBER OF NIOBRARA FORMATION	211FRHS
FRUITLAND FORMATION	211FRLD
FAIRPORT CHALKY SHALE MEMBER OF CARLILE SHALE	211FRPR
FOX HILLS SANDSTONE	211FXHL
GREENHORN LIMESTONE	211GRNR
GRANEROS SHALE	211GRRS
HARTLAND SHALE MEMBER OF GREENHORN LIMESTONE	211HRLD

Appendix E cont.

HYGIENE SANDSTONE MEMBER OF PIERRE SHALE	211HYGN
LINCOLN MEMBER OF GREENHORN LIMESTONE	211LNCL
LARAMIE FORMATION	211LRMI
LARIMER SANDSTONE MEMBER OF PIERRE SHALE	211LRMR
LEWIS SHALE	211LWIS
MCDERMOTT MEMBER OF ANIMAS FORMATION	211MCDM
MENEFEE FORMATION OF MESAVERDE GROUP	211MENF
MILLIKEN SANDSTONE MEMBER OF FOX HILLS SANDSTONE	211MLKN
MANCOS SHALE	211MNCS
MESAVERDE GROUP	211MVRD
NIOBRARA FORMATION	211NBRR
PICTURED CLIFFS SANDSTONE	211PCCF
PIERRE SHALE	211PIRR
POINT LOOKOUT SANDSTONE MEMBER OF MESAVERDE GROUP	211PNLK
RICHARD SANDSTONE MEMBER OF PIERRE SHALE	211RCRD
ROCKY RIDGE SANDSTONE MEMBER OF PIERRE SHALE	211RKRG
SMOKY HILL MARL MEMBER OF NIOBRARA FORMATION	211SMKH
TRINIDAD SANDSTONE	211TRDD
TRANSITION ZONE	211TRNS
TERRY SANDSTONE MEMBER OF PIERRE SHALE	211TRRY
VERMEJO FORMATION	211VRMJ

LOWER CRETACEOUS

BURRO CANYON FORMATION	217BRCN
LOWER CRETACEOUS SERIES	217CRCSL
CHEYENNE SANDSTONE MEMBER OF PURGATORIE FORMATION	217CYNN
KIOWA SHALE MEMBER OF PURGATORIE FORMATION	217KIOW
LYTLE FORMATION OF DAKOTA GROUP	217LYTL
MOWRY SHALE	217MWRY
PLAINVIEW SANDSTONE MEMBER OF SOUTH PLATTE FORMATION	217PLNV
PURGATORIE FORMATION	217PRGR
SOUTH PLATTE FORMATION OF DAKOTA GROUP	217STPL

JURASSIC

GLEN CANYON GROUP	220GLNC
JURASSIC-TRIASSIC SYSTEMS	220JCTC
JURASSIC SYSTEM	220JRSC
NAVAJO SANDSTONE OF GLEN CANYON GROUP	220NVJO

UPPER JURASSIC

BRUSHY BASIN SHALE MEMBER OF MORRISON FORMATION	221BRSB
CURTIS FORMATION OF SAN RAFAEL GROUP	221CRTS
ENTRADA SANDSTONE	221ENRD
JUNCTION CREEK SANDSTONE OF SAN RAFAEL GROUP	221JCCK
UPPER JURASSIC SERIES	221JRSCU
MOAB MEMBER OF ENTRADA SANDSTONE	221MOAB
MORRISON FORMATION	221MRSN
RECAPTURE SHALE MEMBER OF MORRISON FORMATION	221RCPR
RALSTON CREEK FORMATION	221RLCK
SLICK ROCK MEMBER OF ENTRADA SANDSTONE	221SKRK
SALT WASH SANDSTONE MEMBER OF MORRISON FORMATION	221SLWS
SUMMERVILLE FORMATION OF SAN RAFAEL GROUP	221SMVL
SAN RAFAEL GROUP	221SRFL

Appendix E cont.

WESTWATER CANYON SANDSTONE MEMBER OF MORRISON FORMATION	221WSRC
MIDDLE JURASSIC	
MIDDLE JURASSIC SERIES	224JRSCM
LOWER JURASSIC	
LOWER JURASSIC SERIES	227JRSCL
TRIASSIC	
LYKINS FORMATION	230LKNS
TRIASSIC-PERMIAN SYSTEMS	230TCPM
TRIASSIC SYSTEM	230TRSC
UPPER TRIASSIC	
CHINLE FORMATION OF DOCKUM GROUP	231CHNL
DOCKUM GROUP	231DCKM
JELM FORMATION	231JELM
KAYENTA FORMATION OF GLEN CANYON GROUP	231KYNT
UPPER TRIASSIC SERIES	231TRSCU
WINGATE SANDSTONE OF GLEN CANYON GROUP	231WNGT
MIDDLE TRIASSIC	
MIDDLE TRIASSIC SERIES	234TRSCM
LOWER TRIASSIC	
LOWER TRIASSIC SERIES	237TRSCL
PALEOZOIC	
PALEOZOIC ERATHEM	300PLZC
PERMIAN	
LYONS FORMATION	310LYNS
PERMIAN-PENNSYLVANIAN SYSTEMS	310PMPV
PERMIAN SYSTEM	310PRMN
SANGRE DE CRISTO FORMATION	310SGRC
SATANKA SHALE	310STNK
UPPER PERMIAN	
BIG BASIN FORMATION	311BGBS
UPPER PERMIAN SERIES	311PRMNU
TALOGA FORMATION OF CRAGIN	311TOLG
LOWER PERMIAN	
FOUNTAIN FORMATION	317FNTN
INGLESIDE FORMATION	317IGLD
LOWER PERMIAN SERIES	317PRMNL

Appendix E cont.

PENNSYLVANIAN	
PENNSYLVANIAN SYSTEM	320PSLV
UPPER PENNSYLVANIAN	
UPPER PENNSYLVANIAN SERIES	321PSLVU
MIDDLE PENNSYLVANIAN	
MIDDLE PENNSYLVANIAN SERIES	324PSLVM
LOWER PENNSYLVANIAN	
LOWER PENNSYLVANIAN SERIES	327PSLVL
MISSISSIPPIAN	
MISSISSIPPIAN SYSTEM	330MSSP
UPPER MISSISSIPPIAN	
LEADVILLE LIMESTONE	331LDVL
UPPER MISSISSIPPIAN SERIES	331MSSPU
LOWER MISSISSIPPIAN	
LOWER MISSISSIPPIAN SERIES	337MSSPL
DEVONIAN	
DEVONIAN SYSTEM	340DVNN
UPPER DEVONIAN	
CHAFFEE FORMATION	341CHFF
UPPER DEVONIAN SERIES	341DVNNU
PARTING QUARTZITE MEMBER OF CHAFFEE FORMATION	341PRTG
LOWER DEVONIAN	
LOWER DEVONIAN SERIES	347DVNNL
SILURIAN	
SILURIAN SYSTEM	350SLRN
UPPER SILURIAN	
UPPER SILURIAN SERIES	351SLRNU
MIDDLE SILURIAN	
MIDDLE SILURIAN SERIES	354SLRNM

Appendix E cont.

LOWER SILURIAN	
LOWER SILURIAN SERIES	357SLRNL
ORDOVICIAN	
ORDOVICIAN SYSTEM	360ODVC
UPPER ORDOVICIAN	
UPPER ORDOVICIAN SERIES	361ODVCU
MIDDLE ORDOVICIAN	
MIDDLE ORDOVICIAN SERIES	364ODVCM
LOWER ORDOVICIAN	
MANITOU FORMATION	367MNTU
LOWER ORDOVICIAN SERIES	367ODVCL
CAMBRIAN	
CAMBRIAN SYSTEM	370CMBR
UPPER CAMBRIAN	
UPPER CAMBRIAN SERIES	371CMBRU
SAWATCH SANDSTONE FORMATION	371SWCH
MIDDLE CAMBRIAN	
MIDDLE CAMBRIAN SERIES	374CMBRM
LOWER CAMBRIAN	
LOWER CAMBRIAN SERIES	377CMBRL
PRECAMBRIAN	
PRECAMBRIAN ERATHEM	400PCMB
PRECAMBRIAN CRYSTALLINE ROCKS	400PCMBC

HAZEL SANDSTONE	400HZEL
LLANO SERIES	400LLNO
PACKSADDLE SCHIST	400PCKD
PRECAMBRIAN ERATHEM	400PCMB
VAN HORN SANDSTONE	400VNHR
VALLEY SPRING GNEISS	400VSPG

UTAH

CENOZOIC

VALLEY FILL OR BASIN FILL	100VLFL

QUATERNARY

HOLOCENE

ALLUVIUM	111ALVM
BEAVER BASIN FORMATION(HOLOCENE-PLEISTOCENE)	111BVRB
GOLD BASIN FORMATION	111GLDB
HOLOCENE SERIES	111HLCN
ICE SPRINGS CRATERS FLOW	111ISPG

PLEISTOCENE

ALPINE FORMATION	112ALPN
AXTELL FORMATION	112AXTL
BONNEVILLE FORMATION OF LAKE BONNEVILLE GROUP	112BNVL
DRAPER FORMATION OF LAKE BONNEVILLE GROUP	112DRPR
EIGHT MILE DACITE(PLEISTOCENE-PLIOCENE)	112EGML
FUMAROLE BUTTE BASALT	112FMLB
HARPOLE MESA FORMATION	112HPLM
LAKE BONNEVILLE GROUP	112LKBV
LITTLE COTTONWOOD FORMATION OF LAKE BONNEVILLE GROUP	112LLCD
PLACER CREEK FORMATION	112PCCK
PLEISTOCENE SERIES	112PLCN
PROVO FORMATION OF LAKE BONNEVILLE GROUP	112PROV
PAVANT FLOW	112PVNT
SALT CREEK FANGLOMERATE	112SLCK
SEVIER RIVER FORMATION(PLEISTOCENE-PLIOCENE)	112SVRV
TABERNACLE FLOW	112TBCL

TERTIARY

BEAVER HILL TUFF OF MOUNT BELKNAP VOLCANIC GROUP	120BVHL
CRAB CREEK FORMATION	120CBCK
CRESCENT HILL RHYOLITE OF MOUNT BELKNAP VOLCANIC GROUP	120CCHL
COVE MOUNTAIN FORMATION	120CVMN
FLATTOP MOUNTAIN SUITE	120FLPM
GOLD MOUNTAIN TUFF OF MOUNT BELKNAP VOLCANIC GROUP	120GLDM
GRAY HILLS ARKOSE OF MOUNT BELKNAP VOLCANIC GROUP	120GRHL
HORN SILVER ANDESITE	120HSLV
INDIAN HOLLOW RHYOLITE OF MOUNT BELKNAP VOLCANIC GROUP	120IDHL
JUDD CREEK LATITE	120JDCK
KEG MOUNTAIN IGNIMBRITES	120KGMN
KEG SPRING ANDESITE,LATITE	120KGSP
KIMBERLY RHYOLITE OF MOUNT BELKNAP VOLCANIC GROUP	120KMBL
KOLOB LATITE	120KOLB
MOUNT BELKNAP RHYOLITE OF MOUNT BELKNAP VOLCANIC GROUP	120MBKP
MORONI FORMATION	120MORN
MAPLE RIDGE PORPHYRY	120MPRG
PINE VALLEY LATITE	120PNVL
RAUL CANYON BASALT	120RLCN

RENCHER FORMATION	120RNCR
SHOAL CREEK BRECCIA	120SLCK
STALEY PASTURE TUFF OF MOUNT BELKNAP VOLCANIC GROUP	120STLY
TIBBLE FORMATION	120TBBL
TOPAZ MOUNTAIN RHYOLITE	120TPZM
TERTIARY SYSTEM	120TRTR

PLIOCENE

BROWNS PARK FORMATION(PLIOCENE-MIOCENE)	121BRPK
CACHE VALLEY GROUP(PLIOCENE-MIOCENE)	121CCVL
CAMP WILLIAMS UNIT OF SALT LAKE FORMATION	121CMPW
COTTONWOOD CANYON FORMATION(PLIOCENE-MIOCENE)	121CNDC
DRY HOLLOW FORMATION	121DRHL
GEYSER PEAK FANGLOMERATE	121GRPK
HARKERS FANGLOMERATE MEMBER OF SALT LAKE FORMATION	121HRKR
HUNTSVILLE FANGLOMERATE	121HSVL
JOE LOTT TUFF	121JLTT
MUDDY CREEK FORMATION	121MDCK
MINK CREEK CONGLOMERATE OF SALT LAKE FORMATION	121MKCK
PLIOCENE SERIES	121PLCN
PARUNUWEAP FORMATION	121PRNP
PAYETTE FORMATION(PLIOCENE-MIOCENE)	121PYTT
ROGER PEAK BASALTIC BRECCIA	121RGPK
SALT LAKE FORMATION	121SLLK
TOPAZ MOUNTAIN TUFF	121TPZM

MIOCENE

AXTELL FORMATION(PLEISTOCENE-PLIOCENE)	122AXTL
BULLION CANYON VOLCANICS	122BLNC
BRIAN HEAD FORMATION	122BRHD
BEAR VALLEY FORMATION	122BRVL
DELANO PEAK LATITE MEMBER OF BULLION CANYON VOLCANICS	122DLPK
JORDAN NARROWS UNIT OF SALT LAKE FORMATION(MIOCENE-OLIGOCENE)	122JRDN
MIOCENE SERIES	122MOCN
PAGE RANCH FORMATION(MIOCENE-OLIGOCENE)	122PGRC
ROCK CANDY AGGLOMERATE AND LATITE OF BULLION CANYON VOLCANICS	122RCKC
TRAVERSE VOLCANICS OF SALT LAKE FORMATION(MIOCENE-OLIGOCENE)	122TRVR

OLIGOCENE

BALD KNOLL FORMATION	123BLDK
BALDHILLS MEMBER OF ISOM FORMATION	123BLDL
CHICKEN CREEK TUFF(OLIGOCENE-EOCENE)	123CKCK
CRAZY HOLLOW FORMATION	123CZHL
DUCHESNE RIVER FORMATION	123DCRV
FOOL CREEK CONGLOMERATE	123FLCK
ISOM FORMATION	123ISOM
NEEDLES RANGE FORMATION	123NDRG
NORWOOD TUFF OF SALT LAKE FORMATION	123NRWD
OLIGOCENE SERIES	123OLGC
PEOA TUFF	123PEOA
PARK CITY VOLCANICS	123PRKC
QUICHAPA FORMATION	123QCHP
ROSE CANYON LATITE-ANDESITE VOLCANICS	123RSCN

SOUTH MOUNTAIN ANDESITE FLOWS	123SMNN
WANRHODES VOLCANICS	123WRDS

EOCENE

APEX CONGLOMERATE	124APEX
CLARON LIMESTONE OR FORMATION	124CLRN
COLTON FORMATION	124CLTN
DOUGLAS CREEK MEMBER OF GREEN RIVER FORMATION	124DGCK
DIPPING VAT FORMATION	124DPGV
EAGLE HILL RHYOLITE	124EGLH
EOCENE SERIES	124EOCN
FLAGSTAFF LIMESTONE(EOCENE-PALEOCENE)	124FLGF
FERNOW QUARTZ LATITE	124FRNW
GARDEN GULCH MEMBER OF GREEN RIVER FORMATION	124GDGC
GOLDENS RANCH FORMATION	124GDRC
GREEN RIVER FORMATION	124GRRV
HORSE BENCH SANDSTONE BED OF UINTA FORMATION	124HRBC
LAGUNA LATITE	124LGUN
PARACHUTE CREEK MEMBER OF GREEN RIVER FORMATION	124PCCK
PACKARD QUARTZ LATITE	124PCKO
SHAGGY PEAK RHYOLITE	124SGPK
TICKVILLE RHYOLITE	124TCKV
TIPTON SHALE MEMBER OF GREEN RIVER FORMATION	124TPTN
UINTA FORMATION	124UINT
WASATCH FORMATION(EOCENE-PALEOCENE)	124WSTC
WHITE SAGE FORMATION	124WTSG

PALEOCENE

CEDAR BREAKS FORMATION	125CDBK
EVANSTON FORMATION(PALEOCENE-UPPER CRETACEOUS)	125EVNS
FORT UNION FORMATION	125FRUN
NORTH HORN FORMATION(PALEOCENE-UPPER CRETACEOUS)	125NRHR
PALEOCENE SERIES	125PLCN

MESOZOIC

BECKWITH FORMATION	200BCKT
MANCOS SHALE	200MNCS
MESOZOIC ERATHEM	200MSZC
STRAIGHT CLIFFS SANDSTONE	200SGCF

CRETACEOUS

CRETACEOUS SYSTEM	210CRCS
DAKOTA SANDSTONE OR FORMATION OR GROUP	210DKOT
TUSHAR CONGLOMERATE	210TSHR

UPPER CRETACEOUS

ABERDEEN SANDSTONE MEMBER OF BLACKHAWK FORMATION	211ABRD
ANCHOR MINE TONGUE OF MANCOS SHALE	211ACRM
ALLEN VALLEY SHALE OF INDIANOLA GROUP	211ALVL
ASPHALT RIDGE SANDSTONE OF MESAVERDE GROUP	211APRG
BLACKHAWK FORMATION OF MESAVERDE GROUP	211BCKK

BENNION CREEK FORMATION	211BCRK
BLUECASTLE SANDSTONE MEMBER	211BLCL
BLUE GATE SHALE MEMBER OF MANCOS SHALE	211BLGT
BLAIR FORMATION OF MESAVERDE GROUP	211BLIR
BUCK TONGUE OF MANCOS SHALE	211BUCK
CURRANT CREEK FORMATION	211CRCK
CASTLEGATE SANDSTONE OF MESAVERDE GROUP	211CSLG
ECHO CANYON CONGLOMERATE	211ECCN
EMERY SANDSTONE MEMBER OF MANCOS SHALE	211EMRY
ERICSON SANDSTONE OR FORMATION OF MESAVERDE GROUP	211ERCS
FUNK VALLEY FORMATION OF INDIANOLA GROUP	211FKVL
FRONTIER FORMATION	211FRNR
FERRON SANDSTONE MEMBER OF MANCOS SHALE	211FRRN
FARRER FORMATION	211FRRR
GARLEY CANYON SANDSTONE MEMBER OF MANCOS SHALE	211GRLC
HILLIARD SHALE OR FORMATION	211HLRD
HENEFER FORMATION	211HNFR
IRON SPRINGS FORMATION	211ISPG
KAIPAROWITS FORMATION	211KPRS
MASUK MEMBER OF MANCOS SHALE	211MSUK
MESAVERDE GROUP	211MVRD
NESLEN FORMATION OF MESAVERDE GROUP	211NSLN
PRICE RIVER FORMATION OF MESAVERDE GROUP	211PCRV
ROCK SPRINGS FORMATION OF MESAVERDE GROUP	211RKSP
SEGO SANDSTONE OF MESAVERDE GROUP	211SEGO
SANPETE FORMATION OF INDIANOLA GROUP	211SNPT
STAR POINT SANDSTONE OF MESAVERDE GROUP	211SRPN
SIXMILE CANYON FORMATION OF INDIANOLA GROUP	211SXMC
TUNUNK SHALE MEMBER OF MANCOS SHALE	211TNNK
TROPIC SHALE OR FORMATION	211TRPC
TUSCHER FORMATION OF MESAVERDE GROUP	211TSCR
WAHWEAP SANDSTONE	211WHWP
WANSHIP FORMATION	211WNSP

LOWER CRETACEOUS

ASPEN SHALE MEMBER OF MANCOS SHALE	217ASPN
BUCKHORN CONGLOMERATE MEMBER OF CEDAR MOUNTAIN FORMATION	217BCKR
BURRO CANYON FORMATION	217BRCN
BEAR RIVER FORMATION	217BRRV
CEDAR MOUNTAIN FORMATION	217CDRM
CLOVERLY FORMATION	217CLVL
KELVIN FORMATION	217KLVN
MOWRY SHALE	217MWRY

JURASSIC

GLEN CANYON FORMATION OR GROUP(JURASSIC-TRIASSIC)	220GLNC
JURASSIC SYSTEM	220JRSC
NAVAJO SANDSTONE OF GLEN CANYON GROUP(JURASSIC-TRIASSIC)	220NVJO

UPPER JURASSIC

ARAPIEN SHALE	221ARPN
BLUFF SANDSTONE OF SAN RAFAEL GROUP	221BLFF
BRUSHY BASIN MEMBER OF MORRISON FORMATION	221BRSB

CARMEL FORMATION OF SAN RAFAEL GROUP	221CRML
CURTIS FORMATION OF SAN RAFAEL GROUP	221CRTS
COW SPRINGS SANDSTONE	221CSPG
DEWEY BRIDGE MEMBER OF ENTRADA SANDSTONE	221DBDG
ENTRADA SANDSTONE OF SAN RAFAEL GROUP	221ENRD
JUNCTION CREEK SANDSTONE OF SAN RAFAEL GROUP	221JCCK
MORRISON FORMATION	221MRSN
PREUSS SANDSTONE OR RED BEDS	221PRSS
RECAPTURE MEMBER OF MORRISON FORMATION	221RCPR
SALT WASH MEMBER OF MORRISON FORMATION	221SLWS
SUMMERVILLE FORMATION OF SAN RAFAEL GROUP	221SMVL
SAN RAFAEL GROUP	221SRFL
STUMP SANDSTONE	221STMP
TWIN CREEK LIMESTONE OR FORMATION	221TCRK
TWIST GULCH MEMBER OF ARAPIEN SHALE	221TGLC
TWELVEMILE CANYON MEMBER OF ARAPIEN SHALE	221TVMC
WINSOR FORMATION OF SAN RAFAEL GROUP	221WNSR
WESTWATER CANYON MEMBER OF MORRISON FORMATION	221WSRC

LOWER JURASSIC

NUGGET SANDSTONE	227NGGT

TRIASSIC

HOSKINNINI MEMBER OF MOENKOPI FORMATION	230HSKN
MOENKOPI FORMATION	230MNKP
TENDERFOOT MEMBER OF MOENKOPI FORMATION	230TDRF
TRIASSIC SYSTEM	230TRSC

UPPER TRIASSIC

ANKAREH SHALE FORMATION OR RED BEDS	231ANKR
CHURCH ROCK MEMBER OF CHINLE FORMATION	231CCRK
CEDAR CITY TONGUE OF KAYENTA FORMATION	231CDRC
CHINLE FORMATION	231CHNL
DINOSAUR CANYON MEMBER OF MOENAVE FORMATION	231DSCR
DINOSAUR CANYON SANDSTONE MEMBER OF MOENAVE FORMATION	231DSRC
GARTRA MEMBER OF CHINLE FORMATION	231GRTR
KAYENTA FORMATION OF GLEN CANYON GROUP	231KYNT
MOSS BACK MEMBER OF CHINLE FORMATION	231MBCK
MONITOR BUTTE MEMBER OF CHINLE FORMATION	231MNRB
MOENAVE FORMATION OF GLEN CANYON GROUP	231MONV
PETRIFIED FOREST MEMBER OF CHINLE FORMATION	231PFDF
SHNABKAIB MEMBER OF MOENKOPI FORMATION	231SBKB
SPRINGDALE SANDSTONE MEMBER OF MOENAVE FORMATION	231SPGD
SHINARUMP MEMBER OF CHINLE FORMATION	231SRMP
SUICIDE GRIT OF ANKAREH FORMATION	231SUCD
TEMPLE MOUNTAIN MEMBER OF CHINLE FORMATION	231TMPM
WHITMORE POINT MEMBER OF MOENAVE FORMATION	231WMRP
WINGATE SANDSTONE OF GLEN CANYON GROUP	231WNGT

MIDDLE TRIASSIC

PARIOTT MEMBER OF MOENKOPI FORMATION	234PRTT
SEWEMUP MEMBER OF MOENKOPI FORMATION	234SWMP

LOWER TRIASSIC

AGATHLA SANDSTONE	237AGTL
ALI BABA MEMBER OF MOENKOPI FORMATION	237ALBB
DINWOODY FORMATION	237DNDY
HARRINGTON FORMATION	237HRNG
MAHOGANY FORMATION	237MGNY
SINBAD LIMESTONE MEMBER OF MOENKOPI FORMATION	237SNBD
TIMPOWEAP MEMBER OF MOENKOPI FORMATION	237TMPP
THAYNES LIMESTONE,FORMATION OR GROUP	237TYNS
VIRGIN LIMESTONE MEMBER OF MOENKOPI FORMATION	237VRGN
WOODSIDE FORMATION SILTSTONE OR RED BEDS	237WDSD

PALEOZOIC

DOVE CREEK FORMATION OR GROUP	300DVCK
PALEOZOIC ERATHEM	300PLZC

PERMIAN

AUBREY GROUP(PERMIAN-PENNSYLVANIAN)	310ABRY
ARCTURUS LIMESTONE OR FORMATION	310ARCR
BIRD SPRING FORMATION(PERMIAN-PENNSYLVANIAN-MISSISSIPPIAN)	310BSPG
COCONINO SANDSTONE OF AUBREY GROUP	310CCNN
CEDAR MESA SANDSTONE MEMBER OF CUTLER FORMATION	310CDRM
CALLVILLE LIMESTONE(PERMIAN-PENNSYLVANIAN-MISSISSIPPIAN)	310CLVL
CUTLER FORMATION	310CTLR
DE CHELLY SANDSTONE MEMBER OF CUTLER FORMATION	310DCLL
DIAMOND CREEK SANDSTONE	310DMCK
GERSTER FORMATION OR LIMESTONE OF PARK CITY GROUP	310GRSR
HALGAITO TONGUE OR MEMBER OF CUTLER FORMATION	310HLGT
HERMIT SHALE OF AUBREY GROUP	310HRMT
INDIAN CANYON FORMATION OF PARK CITY GROUP	310INDC
KAIBAB LIMESTONE	310KIBB
KIRKMAN LIMESTONE	310KRKM
LORAY FORMATION	310LORY
ORGAN ROCK TONGUE OR MEMBER OF CUTLER FORMATION	310OGRK
OQUIRRH GROUP (PERMIAN-PENNSYLVANIAN-MISSISSIPPIAN)	310OQRR
PAKOON LIMESTONE	310PKON
PLYMPTON FORMATION OF PARK CITY GROUP	310PLMP
PARK CITY FORMATION OR GROUP	310PRKC
PERMIAN SYSTEM	310PRMN
PHOSPHORIA FORMATION	310PSPR
RICO FORMATION(PERMIAN-UPPER PENNSYLVANIAN)	310RICO
RIEPE SPRING LIMESTONE	310RPSP
RIEPETOWN SANDSTONE	310RPTN
SUPAI FORMATION OF AUBREY GROUP(PERMIAN-PENNSYLVANIAN)	310SUPI
TOROWEAP FORMATION OF AUBREY GROUP	310TRWP
WEBER QUARTZITE OR SANDSTONE(PERMIAN-PENNSYLVANIAN)	310WEBR
WELLS FORMATION(PERMIAN-PENNSYLVANIAN)	310WLLS
WHITE RIM SANDSTONE MEMBER OF CUTLER FORMATION	310WTRM

LOWER PERMIAN

QUEANTOWEAP SANDSTONE	317QNTP

WOLFCAMPIAN

ELEPHANT CANYON FORMATION	319ELPC

PENNSYLVANIAN

ELEPHANT LIMESTONE	320ELPN
ELY LIMESTONE	320ELY
MANNING CANYON SHALE(PENNSYLVANIAN-MISSISSIPPIAN)	320MNGC
MOLAS FORMATION(PENNSYLVANIAN-MISSISSIPPIAN)	320MOLS
PENNSYLVANIAN SYSTEM	320PSLV
TILDEN LIMESTONE LENTIL	320TLDN
TALISMAN QUARTZITE	320TLSM

UPPER PENNSYLVANIAN

BINGHAM MINE FORMATION OF OQUIRRH GROUP	321BGMM
HONAKER TRAIL MEMBER OF HERMOSA FORMATION	321HKTL
KESSLER CANYON FORMATION OF OQUIRRH GROUP	321KLRC

MIDDLE PENNSYLVANIAN

ERDA FORMATION OF OQUIRRH GROUP	324ERDA
HOGAN FORMATION	324HOGN
HERMOSA FORMATION	324HRMS
MORGAN FORMATION	324MRGN
PARADOX MEMBER OF HERMOSA FORMATION	324PRDX

LOWER PENNSYLVANIAN

LAKE POINT LIMESTONE OF OQUIRRH GROUP	327LKPN
PINKERTON TRAIL LIMESTONE MEMBER OF HERMOSA FORMATION	327PKRT
WEST CANYON LIMESTONE OF OQUIRRH GROUP	327WSCN

MISSISSIPPIAN

BRAZER LIMESTONE OR DOLOMITE	330BRZR
DESERET LIMESTONE	330DSRT
LEADVILLE LIMESTONE	330LDVL
MADISON GROUP	330MDSN
MISSISSIPPIAN SYSTEM	330MSSP
REDWALL LIMESTONE	330RDLL
STANSBURY FORMATION(MISSISSIPPIAN-DEVONIAN)	330SSBR
TOPACHE LIMESTONE(MISSISSIPPIAN-DEVONIAN)	330TPCH

UPPER MISSISSIPPIAN

CHESTERFIELD RANGE GROUP	331CFDR
CHAINMAN SHALE	331CNMN
DOUGHNUT FORMATION	331DGNT
DIAMOND PEAK FORMATION	331DMPK
GREAT BLUE LIMESTONE OR FORMATION	331GRBL
GREEN RAVINE FORMATION	331GRRV
HUMBUG FORMATION	331HMBG
OCHRE MOUNTAIN LIMESTONE	331OCRM
WOODMAN FORMATION	331WDMN

LOWER MISSISSIPPIAN

FITCHVILLE FORMATION	337FCVL
GARDISON LIMESTONE	337GRDS
JOANA LIMESTONE	337JOAN
LODGEPOLE LIMESTONE OF MADISON GROUP	337LDGP
LEATHAM FORMATION	337LTHM
NARROW CANYON LIMESTONE(LOWER MISSISSIPPIAN-UPPER DEVONIAN)	337NRCN
PILOT SHALE(LOWER MISSISSIPPIAN-UPPER DEVONIAN)	337PLOT
PINYON PEAK LIMESTONE(LOWER MISSISSIPPIAN-UPPER DEVONIAN)	337PNPK

DEVONIAN

BLUEBELL DOLOMITE(DEVONIAN-SILURIAN-ORDOVICIAN)	340BLBL
DEVONIAN SYSTEM	340DVNN
KINGS CANYON DOLOMITE	340KGSC
RED WARRIOR LIMESTONE(DEVONIAN-SILURIAN-ORDOVICIAN)	340RDWR

UPPER DEVONIAN

ANETH FORMATION	341ANTH
BEIRDNEAU FORMATION	341BRDN
COVE FORT QUARTZITE	341CVFR
ENGELMANN FORMATION(UPPER-MIDDLE DEVONIAN)	341EGLM
ELBERT FORMATION	341ELBR
GUILMETTE FORMATION	341GLMT
GILSON DOLOMITE	341GLSN
GOSHOOT FORMATION	341GSHT
HANAUER FORMATION	341HNUR
HYRM DOLOMITE(UPPER-MIDDLE DEVONIAN)	341HYRM
JEFFERSON LIMESTONE,DOLOMITE OR FORMATION	341JFRS
MOWITZA SHALE	341MWTZ
OURAY LIMESTONE	341OURY
VICTORIA FORMATION	341VCTR

MIDDLE DEVONIAN

MUDDY PEAK LIMESTONE	344MDPK
SEVY DOLOMITE(LOWER DEVONIAN-UPPER SILURIAN)	344SEVY
SIMONSON DOLOMITE	344SMNS

SILURIAN

BEAVER LAKE DOLOMITE(SILURIAN-UPPER ORDOVICIAN)	350BVLK
DECATHON DOLOMITE	350DCTN
FLORIDE DOLOMITE	350FLRD
JACK VALLEY FORMATION	350JCKV
LIME MOUNTAIN DOLOMITE	350LMMN
LONE MOUNTAIN DOLOMITE	350LNMN
SILURIAN SYSTEM	350SLRN

MIDDLE SILURIAN

BELL HILL DOLOMITE	354BLHL
HARRISITE DOLOMITE	354HRST
LOST SHEEP DOLOMITE	354LSSP

ROBERTS MOUNTAIN FORMATION OR LIMESTONE	354RBRM
THURSDAY DOLOMITE	354TRSD

ORDOVICIAN

CHOKECHERRY DOLOMITE(ORDOVICIAN-UPPER CAMBRIAN)	360CKCR
GRAMPIAN LIMESTONE(ORDOVICIAN-CAMBRIAN)	360GRMP
HOUSE LIMESTONE OF POGONIP GROUP(ORDOVICIAN-CAMBRIAN)	360HOUS
ORDOVICIAN SYSTEM	360ODVC
POGONIP GROUP(ORDOVICIAN-CAMBRIAN)	360PGNP

UPPER ORDOVICIAN

EUREKA QUARTZITE	361EURK
FISH HAVEN DOLOMITE	361FSHV

MIDDLE ORDOVICIAN

GARDEN CITY FORMATION OR LIMESTONE(MIDDLE-LOWER ORDOVICIAN)	364GRDC
KANOSH SHALE OF POGONIP GROUP	364KNSH
LEHMAN FORMATION OF POGONIP GROUP	364LHMN
SWAN PEAK FORMATION	364SNPK

LOWER ORDOVICIAN

FILLMORE LIMESTONE OF POGONIP GROUP	367FLMR
JUAB LIMESTONE OF POGONIP GROUP	367JUAB
OPOHONGA LIMESTONE	367OPNG
WAHWAH LIMESTONE OF POGONIP GROUP	367WHWH

CAMBRIAN

CAMBRIAN SYSTEM	370CMBR
MOREHOUSE QUARTZITE	370MRHS
PINE VALLEY QUARTZITE	370PNVL

UPPER CAMBRIAN

AJAX DOLOMITE	371AJAX
CORSET SPRING SHALE	371CSPG
DUNDERBURG SHALE	371DDBG
DUGWAY RIDGE DOLOMITE	371DGRG
FERA LIMESTONE	371FERA
HICKS FORMATION	371HCKS
LAMB DOLOMITE(UPPER-MIDDLE CAMBRIAN)	371LAMB
LODORE FORMATION OR SHALE	371LODR
LYNCH DOLOMITE(UPPER-MIDDLE CAMBRIAN)	371LYNC
NOTCH PEAK LIMESTONE	371NCPK
NOUNAN LIMESTONE(UPPER-MIDDLE CAMBRIAN)	371NUNN
OPEX FORMATION	371OPEX
ORR FORMATION	371ORR
ST CHARLES LIMESTONE	371SCRL
STRAIGHT CANYON FORMATION	371SRGC

MIDDLE CAMBRIAN

ABERCROMBIE FORMATION	374ABMB
BLACKSMITH DOLOMITE OR LIMESTONE	374BCKM
BLUEBIRD DOLOMITE	374BLBD
BLOOMINGTON FORMATION	374BLMG
BRIGHAM QUARTZITE(MIDDLE CAMBRIAN-UPPER PRECAMBRIAN)	374BRGM
BOWMAN LIMESTONE	374BWMN
COLE CANYON DOLOMITE	374CLCN
CHISHOLM SHALE	374CSLM
DAGMAR DOLOMITE	374DGMR
DOME LIMESTONE	374DOME
FANDANGLE LIMESTONE	374FDGL
HERKIMER LIMESTONE	374HRKM
HARTMANN LIMESTONE	374HRMN
HOWELL FORMATION	374HWLL
LYNDON LIMESTONE	374LNDN
LANGSTON LIMESTONE	374LNGS
MARJUM LIMESTONE	374MRJM
MAXFIELD LIMESTONE	374MXFD
OPHIR FORMATION OR SHALE	374OPHR
PIOCHE SHALE(MIDDLE-LOWER CAMBRIAN)	374POCH
SHADSCALE FORMATION	374SDCL
SWASEY FORMATION	374SWSY
TINTIC QUARTZITE(MIDDLE-LOWER CAMBRIAN)	374TNTC
TRAILER LIMESTONE	374TRLR
TRIPPE LIMESTONE	374TRPP
TEUTONIC LIMESTONE	374TTNC
UTE LIMESTONE	374UTE
WEEKS LIMESTONE(UPPER-MIDDLE CAMBRIAN)	374WEKS
WHEELER FORMATION	374WHLR
WHIRLWIND FORMATION	374WRLD
YOUNG PEAK DOLOMITE	374YGPK

LOWER CAMBRIAN

BUSBY QUARTZITE	377BSBY
CABIN SHALE	377CBIN
PROSPECT MOUNTAIN QUARTZITE(LOWER CAMBRIAN-UPPER PRECAMBRIAN)	377PPCM

PRECAMBRIAN

ALBION RANGE GROUP	400ABRG
AUTS CANYON FORMATION OF SHEEPROCK GROUP	400ASCN
BIG COTTONWOOD FORMATION	400BGCD
BALD MOUNTAIN FORMATION	400BLDM
GREEN CREEK COMPLEX	400CRCK
EKKER FORMATION OF SHEEPROCK GROUP	400EKKR
FARMINGTON CANYON COMPLEX	400FMGC
HORSE CANYON FORMATION	400HRSC
LITTLE WILLOW SERIES	400LLWL
MC COY CREEK GROUP	400MCCK
MINERAL FORK TILLITE	400MLFK
MUTUAL FORMATION	400MUTL
PRECAMBRIAN ERATHEM	400PCMB
RED CREEK QUARTZITE	400RDCK

RED PINE SHALE OF UINTA MOUNTAIN GROUP	400RDPN
SHEEPROCK GROUP OR SERIES	400SPCK
UINTA MOUNTAIN GROUP	400UNMN
WILDHORSE CANYON SERIES	400WLDC

WYOMING

CENOZOIC

CENOZOIC ERATHEM	100CNZC

QUATERNARY

QUATERNARY SYSTEM	110QRNR

HOLOCENE

ALLUVIUM	111ALVM
EOLIAN DEPOSITS	111EOLN
HOLOCENE SERIES	111HLCN
HYDROTHERMAL DEPOSITS	111HTML
KAYCEE FORMATION	111KYCE
LACUSTRINE DEPOSITS	111LCTN
LANDSLIDE DEPOSITS	111LDLD
LIGHTING FORMATION	111LGNG
SAND DUNE DEPOSITS	111SNDD
TERRACE DEPOSITS	111TRRC
UCROSS FORMATION	111UCRS

PLEISTOCENE

ARVADA FORMATION	112ARVD
BULL LAKE DRIFT	112BLLK
BASALT FLOWS	112BSLT
BIVOUAC FORMATION	112BVUC
CEDAR RIDGE TILL	112CDRG
DINWOODY LAKE TILL	112DDLK
EOLIAN DEPOSITS	112EOLN
FENTON PASS FORMATION	112FNPS
GLACIAL DEPOSITS	112GLCL
PLEISTOCENE SERIES	112PLSC
PINEDALE DRIFT	112PNDL
RHYOLITE FLOWS	112RYLT
SACAGEWEA RIDGE TILL	112SCGR
SEDIMENTARY ROCKS	112SDRY
TERRACE DEPOSITS	112TRRC
YELLOWSTONE GROUP	112YLSN

TERTIARY

BASALT	120BSLT
EXTRUSIVE ROCK	120EXTV
INTRUSIVE ROCK	120INTV
TERTIARY SYSTEM	120TRTR

PLIOCENE

BURNT GULCH CONGLOMERATE	121BGLC
BROWNS PARK FORMATION	121BRPK
CANYON BASALT	121CNYN
CAMP DAVIS FORMATION	121CPDV

FOWKES FORMATION	121FWKS
GOOSEBERRY MEMBER OF FOWKES FORMATION	121GSBR
MOONSTONE FORMATION	121MNSN
NORTH PARK FORMATION	121NRPK
OGALLALA FORMATION	121OGLL
PLIOCENE SERIES	121PLCN
SALT LAKE FORMATION	121SLLK
SPOON BUTTE BEDS	121SPNB
TEEWINOT FORMATION	121TWNT

MIOCENE

ARIKAREE FORMATION	122ARKR
BISHOP CONGLOMERATE	122BSHP
COLTER FORMATION	122CLTR
MIOCENE SERIES	122MOCN
SHERMAN DIORITE	122SRMN

OLIGOCENE

BIG SAND DRAW SANDSTONE LENTIL OF WHITE RIVER FORMATION	123BGSD
BRULE FORMATION	123BRUL
BEAVER DIVIDE CONGLOMERATE MEMBER OF WHITE RIVER FORMATION	123BVDV
CHADRON FORMATION	123CDRN
CALDWELL CANYON VOLCANICS	123CLDC
HAT CREEK BEDS	123HCRK
OLIGOCENE SERIES	123OLGC
SWEETWATER MEMBER OF WHITE RIVER FORMATION	123STTR
TATEMAN MOUNTAIN GRAVEL	123TMNM
WIGGINS FORMATION	123WGNS
WHITE RIVER FORMATION OR GROUP	123WRVR
YODER FORMATION	123YODR

EOCENE

ABSAROKA VOLCANIC SUPERGROUP	124ABRK
AYCROSS FORMATION	124ACRS
ALKALI CREEK STRATUM OF WIND RIVER FORMATION	124AKCK
ANGELO MEMBER OF GREEN RIVER FORMATION	124ANGL
BULLDOG HOLLOW MEMBER OF FOWKES FORMATION	124BDGH
BLACKS FORK MEMBER OF BRIDGER FORMATION	124BKFK
BLACK ROCK COAL GROUP	124BKRK
BULLPEN MEMBER OF WASATCH FORMATION	124BLPN
BRIDGER FORMATION	124BRDG
BURNT FORK WHITE LAYER	124BRFK
BATES HOLE FORMATION	124BSHL
BATTLE SPRING FORMATION	124BSPG
CATHEDRAL BLUFFS TONGUE OF WASATCH FORMATION	124CDBF
COTTONWOOD DRAW BANDED LAYERS OF WIND RIVER FORMATION	124CDDR
CHAPPO MEMBER OF WASATCH FORMATION	124CHPP
CLEAR CREEK GRAVELS	124CLCK
CONTINENTAL PEAK FORMATION	124CLPK
COTTONWOOD WHITE LAYERS	124CNDW
EOCENE SERIES	124EOCN
FONTENELLE MEMBER OF GREEN RIVER FORMATION	124FNNL
FOSSIL BUTTE MEMBER OF GREEN RIVER FORMATION	124FSLB

GREEN COVE BEDS	124GRCV
GREENIAN SERIES	124GRNN
GREEN RIVER FORMATION	124GRRV
HANNA FORMATION	124HANN
HOBACK FORMATION	124HBCK
HENRY RANCH MEMBER OF TEPEE TRAIL FORMATION	124HRRC
HIAWATHA MEMBER OF WASATCH FORMATION	124HWTH
KINGSBURY CONGLOMERATE MEMBER OF WASATCH FORMATION	124KGBR
LA BARGE MEMBER OF WASATCH FORMATION	124LBRG
LANEY SHALE MEMBER OF GREEN RIVER FORMATION	124LNEY
LOST CABIN MEMBER OF WIND RIVER FORMATION	124LSCB
LONE TREE GULCH ASH	124LTGC
LUMAN TONGUE OF GREEN RIVER FORMATION	124LUMN
LYSITE MEMBER OF WIND RIVER FORMATION	124LYST
MONCRIEF MEMBER OF WASATCH FORMATION	124MCRF
NEWBERGER SAND (SUBSURFACE)	124NBRG
NEW FORK TONGUE OF WASATCH FORMATION	124NFRK
NILAND TONGUE OF WASATCH FORMATION	124NLND
PITCHFORK FORMATION	124PCFK
PASS PEAK CONGLOMERATE	124PSPK
RED DESERT TONGUE OF WASATCH FORMATION	124RDDR
RAMSHORN VOLCANIC SERIES	124RMSR
SILLEM MEMBER OF FOWKES FORMATION	124SLLM
TWIN BUTTES MEMBER OF BRIDGER FORMATION	124TNBS
TEPEE TRAIL FORMATION	124TPTL
TIPTON SHALE MEMBER OF GREEN RIVER FORMATION	124TPTN
TATMAN FORMATION	124TTMN
TUNP MEMBER OF WASATCH FORMATION	124TUNP
UINTA FORMATION	124UINT
ULM COAL GROUP OF WASATCH FORMATION	124ULM
WIND RIVER FORMATION	124WDRV
WAGON BED FORMATION	124WGBD
WAGONHOUND MEMBER OF UINTA FORMATION	124WGND
WILKINS PEAK MEMBER OF GREEN RIVER FORMATION	124WKPK
WILSON SAND	124WLSN
WILLWOOD FORMATION	124WLWD
WASHAKIE FORMATION	124WSHK
WASATCH FORMATION	124WSTC

PALEOCENE

EVANSTON FORMATION	125EVNS
FERRIS FORMATION	125FRRS
FORT UNION FORMATION	125FRUN
HAMS FORK CONGLOMERATE MEMBER OF EVANSTON FORMATION	125HMFK
LOBO SHALE MEMBER OF FORT UNION FORMATION	125LOBO
MANTUA LENTIL OF POLECAT BENCH FORMATION	125MNTU
POLECAT BENCH FORMATION	125PCBC
PALEOCENE SERIES	125PLCN
PINYON CONGLOMERATE	125PNYN
ROCK BENCH QUARRY BEDS OF POLECAT BENCH FORMATION	125RKBQ
SILVER COULEE BEDS OF POLECAT BENCH FORMATION	125SLVC
SHOTGUN MEMBER OF FORT UNION FORMATION	125STGN
TONGUE RIVER MEMBER OF FORT UNION FORMATION	125TGRV
TULLOCK MEMBER OF FORT UNION FORMATION	125TULK
WALTMAN SHALE MEMBER OF FORT UNION FORMATION	125WLMN

MESOZOIC

MESOZOIC ERATHEM	200MSZC

CRETACEOUS

CRETACEOUS SYSTEM	210CRCS

UPPER CRETACEOUS

ADAVILLE FORMATION	211ADVL
ALMOND FORMATION	211ALMD
ALLEN RIDGE FORMATION	211ARDG
BLACK BUTTES COAL GROUP	211BCKB
BACON RIDGE SANDSTONE	211BCRG
BLIND BULL FORMATION	211BLDB
BELLE FOURCHE SHALE	211BLFC
BLAIR FORMATION	211BLIR
BOW FORMATION OR GROUP	211BOW
BASIN SHALE	211BSIN
BAXTER SHALE	211BXTR
CHIMNEY ROCK TONGUE OF BLAIR FORMATION	211CMRK
CODY SHALE	211CODY
UPPER CRETACEOUS SERIES	211CRCSU
CARLILE SHALE	211CRLL
DAKOTA SANDSTONE OR FORMATION	211DKOT
EAGLE SANDSTONE	211EGLE
ELK BASIN SANDSTONE MEMBER OF TELEGRAPH CREEK FORMATION	211ELKB
ERICSON SANDSTONE OR FORMATION	211ERCS
EVERTS FORMATION	211EVRS
FRONTIER FORMATION	211FRNR
FITZHUGH SAND (SUBSURFACE)	211FTZG
FOX HILLS SANDSTONE	211FXHL
GAMMON FERRUGINOUS MEMBER OF PIERRE SHALE	211GMMN
GREENHORN LIMESTONE	211GRNR
GRANEROS SHALE	211GRRS
HAYSTACK MOUNTAINS FORMATION	211HCKM
HAILEY SHALE	211HILY
HILLIARD SHALE OR FORMATION	211HLRD
HAREBELL FORMATION	211HRBL
HYGIENE SANDSTONE	211HYGN
ILES FORMATION	211ILES
KARA BENTONITIC MEMBER OF PIERRE SHALE	211KARA
KNOBS-CHEROKEE COAL GROUP	211KBCK
KIMBALL SAND (SUBSURFACE)	211KMBL
LANDSLIDE CREEK FORMATION	211LDCK
LANCE FORMATION	211LNCE
LARAMIE FORMATION	211LRMI
LEWIS SHALE	211LWIS
LAZEART SANDSTONE MEMBER OF ADAVILLE FORMATION	211LZRT
MEDICINE BOW FORMATION	211MDCB
MONUMENT HILL BENTONTIC MEMBER OF PIERRE SHALE	211MMHL
MANCOS SHALE	211MNCS
MITTEN BLACK SHALE MEMBER OF PIERRE SHALE	211MTTN
MEETEETSE FORMATION	211MTTS
MESAVERDE FORMATION OR GROUP	211MVRD

NIOBRARA FORMATION	211NBRR
OCTH LOUIE SAND (SUBSURFACE)	211OCTL
OYSTER RIDGE SANDSTONE MEMBER OF FRONTIER FORMATION	211ORDG
PEDRO BENTONITE BED OF PIERRE SHALE	211PDRO
PEAY SANDSTONE MEMBER OF FRONTIER FORMATION	211PEAY
PINEY FORMATION	211PINY
PIERRE SHALE	211PIRR
POOL CREEK SHALE MEMBER OF CARLILE SHALE	211PLCK
PINE RIDGE SANDSTONE	211PRDG
PARKMAN SANDSTONE MEMBER OF MESAVERDE FORMATION	211PRKM
QUEALY SAND (SUBSURFACE)	211QULY
RED BIRD SILTY MEMBER OF PIERRE SHALE	211RDBD
ROCK SPRINGS FORMATION	211RKSP
RAWLINS SANDSTONE	211RLNS
SHANNON SANDSTONE MEMBER OF CODY SHALE	211SNNN
SUSSEX SANDSTONE MEMBER OF CODY SHALE	211SSSX
STEELE SHALE	211STEL
TORCHLIGHT SANDSTONE MEMBER OF FRONTIER FORMATION	211TCLG
TELEGRAPH CREEK FORMATION	211TPCK
TEAPOT SANDSTONE MEMBER OF MESAVERDE FORMATION	211TPOT
TORRINGTON MEMBER OF LANCE FORMATION	211TRNG
TURNER SANDY MEMBER OF CARLILE SHALE	211TRNR
WALL CREEK SANDSTONE MEMBER OF FRONTIER FORMATION	211WLCK

LOWER CRETACEOUS

ASPEN SHALE OR FORMATION	217ASPN
BECHLER CONGLOMERATE	217BCLR
BIRDHEAD SANDSTONE MEMBER OF CLOVERLY FORMATION	217BRDD
BARRETT SHALE	217BRRT
BEAR RIVER FORMATION	217BRRV
COKEVILLE FORMATION	217CKVL
CHILSON MEMBER OF LAKOTA FORMATION	217CLSN
CLAY SPUR BENTONITE BED OF MOWRY SHALE	217CLSP
CLOVERLY FORMATION	217CLVL
LOWER CRETACEOUS SERIES	217CRCSL
DRANEY LIMESTONE	217DRNY
EPHRAIM CONGLOMERATE	217EPRM
FALL RIVER FORMATION	217FLRV
FUSON MEMBER OF LAKOTA FORMATION	217FUSN
GANNETT GROUP	217GNNT
GREYBULL SANDSTONE MEMBER OF CLOVERLY FORMATION	217GRBL
HAY CREEK FORMATION	217HCRK
INYAN KARA GROUP	217INKR
KEYHOLE SANDSTONE MEMBER OF FALL RIVER FORMATION	217KYHL
LAKOTA FORMATION	217LKOT
MUDDY SANDSTONE MEMBER OF THERMOPOLIS SHALE	217MDDY
MINNEWASTE LIMESTONE MEMBER OF LAKOTA FORMATION	217MNST
MOWRY SHALE	217MWRY
NEWCASTLE SANDSTONE	217NCSL
PETERSON LIMESTONE	217PRSN
QUEALY FORMATION	217QULY
SUBLETTE FORMATION	217SBLT
SAGE JUNCTION FORMATION	217SGJC
SKULL CREEK SHALE	217SKCK
SMITHS FORMATION	217SMTS

THOMAS FORK FORMATION	217TMFK
THERMOPOLIS SHALE	217TMPL

JURASSIC

JURASSIC SYSTEM	220JRSC

UPPER JURASSIC

CARMEL FORMATION	221CRML
CURTIS FORMATION	221CRTS
CANYON SPRINGS SANDSTONE MEMBER OF SUNDANCE FORMATION	221CSPG
GYPSUM SPRING FORMATION	221GPSP
HULETT SANDSTONE MEMBER OF SUNDANCE FORMATION	221HLTT
UPPER JURASSIC SERIES	221JRSCU
LAK MEMBER OF SUNDANCE FORMATION	221LAK
MORRISON FORMATION	221MRSN
PREUSS SANDSTONE OR REDBEDS	221PRSS
RIERDON FORMATION	221RRDN
STOCKADE BEAVER SHALE MEMBER OF SUNDANCE FORMATION	221SKBV
SUNDANCE FORMATION	221SNDC
STUMP SANDSTONE	221STMP
SWIFT FORMATION	221SWFT

MIDDLE JURASSIC

MIDDLE JURASSIC SERIES	224JRSCM
SAWTOOTH FORMATION	224STTH
TWIN CREEK LIMESTONE OR FORMATION	224TCRK

LOWER JURASSIC

LOWER JURASSIC SERIES	227JRSCL
NUGGET SANDSTONE	227NGGT

TRIASSIC

TRIASSIC SYSTEM	230TRSC

UPPER TRIASSIC

ALCOVA LIMESTONE	231ALCV
ANKAREH SHALE,FORMATION,OR RED BEDS	231ANKR
CHUGWATER FORMATION OR GROUP	231CGTR
CROW MOUNTAIN SANDSTONE MEMBER OF CHUGWATER FORMATION	231CRMN
JELM FORMATION	231JELM
POPO AGIE MEMBER OF CHUGWATER FORMATION	231PPAG
UPPER TRIASSIC SERIES	231TRSCU
WYOPO FORMATION	231WYOP

LOWER TRIASSIC

DINWOODY FORMATION	237DNDY
ERVAY MEMBER OF GOOSE EGG FORMATION	237ERVY
FREEZEOUT SHALE MEMBER OF GOOSE EGG FORMATION	237FRZT
GOOSE EGG FORMATION	237GSEG

LITTLE MEDICINE MEMBER OF GOOSE EGG FORMATION	237LMDC
RED PEAK FORMATION	237RDPK
SPEARFISH FORMATION	237SPRF
LOWER TRIASSIC SERIES	237TRSCL
THAYNES LIMESTONE	237TYNS
WOODSIDE FORMATION	237WDSD

PALEOZOIC

PALEOZOIC ERATHEM	300PLZC

PERMIAN

PERMIAN SYSTEM	310PRMN

UPPER PERMIAN

DIFFICULTY SHALE MEMBER OF GOOSE EGG FORMATION	311DFCL
FRANSON MEMBER OR TONGUE OF PARK CITY FORMATION	311FRNS
FREEZEOUT TONGUE OF CHUGWATER FORMATION	311FRZT
GLENDO SHALE MEMBER OF GOOSE EGG FORMATION	311GLND
GRANDEUR MEMBER OF PARK CITY FORMATION	311GRDR
MEADE PEAK PHOSPHATIC SHALE MEMBER OF PHOSPHORIA FORMATION	311MDPK
PARK CITY FORMATION	311PRKC
UPPER PERMIAN SERIES	311PRMNU
PHOSPHORIA FORMATION	311PSPR
RETORT PHOSPHATIC SHALE MEMBER OF PHOSPHORIA FORMATION	311RTRT
REX CHERT MEMBER OF PHOSPHORIA FORMATION	311RXCR
SHEDHORN SANDSTONE	311SDRN

LOWER PERMIAN

CASPER FORMATION	317CSPR
CONVERSE SANDSTONE BED OF HARTVILLE FORMATION	317CVRS
FOUNTAIN FORMATION	317FNTN
FORELLE LIMESTONE MEMBER OF GOOSE EGG FORMATION	317FRLL
HARTVILLE FORMATION	317HRVL
INGLESIDE FORMATION	317IGLD
MINNEKAHTA LIMESTONE	317MNKT
MINNELUSA FORMATION	317MNLS
MAROON FORMATION	317MRON
OPECHE SHALE	317OPCH
POPE SPRINGS SANDSTONE	317PPSP
LOWER PERMIAN SERIES	317PRMNL
SYBILLE TONGUE OF PHOSPHORIA FORMATION	317SBLL
SATANKA SHALE	317STNK
TOSI CHERT MEMBER OR TONGUE OF PHOSPHORIA FORMATION	317TOSI
TENSLEEP SANDSTONE	317TSLP
WELLS FORMATION	317WLLS

PENNSYLVANIAN

PENNSYLVANIAN SYSTEM	320PSLV

MIDDLE PENNSYLVANIAN

MORGAN FORMATION	324MRGN
MIDDLE PENNSYLVANIAN SERIES	324PSLVM

LOWER PENNSYLVANIAN

AMSDEN FORMATION	327AMSD
BELL SAND (SUBSURFACE)	327BELL
DARWIN SANDSTONE MEMBER OF AMSDEN FORMATION	327DRWN
FAIRBANK FORMATION	327FRBK
LOWER PENNSYLVANIAN SERIES	327PSLVL
QUADRANT QUARTZITE OR FORMATION	327QDRN
ROUND VALLEY LIMESTONE	327RDVL

MISSISSIPPIAN

MISSISSIPPIAN SYSTEM	330MSSP

UPPER MISSISSIPPIAN

MADISON FORMATION OR GROUP	331MDSN
MISSION CANYON LIMESTONE	331MSNC
UPPER MISSISSIPPIAN SERIES	331MSSPU

LOWER MISSISSIPPIAN

DARBY FORMATION	337DRBY
GUERNSEY FORMATION	337GRNS
LODGEPOLE LIMESTONE	337LDGP
LOWER MISSISSIPPIAN SERIES	337MSSPL
PAHASAPA LIMESTONE	337PHSP
THREE FORKS LIMESTONE OR FORMATION	337TRFK

DEVONIAN

DEVONIAN SYSTEM	340DVNN

UPPER DEVONIAN

UPPER DEVONIAN SERIES	341DVNNU
JEFFERSON FORMATION	341JFRS

LOWER DEVONIAN

BEARTOOTH BUTTE FORMATION	347BRTB
LOWER DEVONIAN SERIES	347DVNNL

ORDOVICIAN

ORDOVICIAN SYSTEM	360ODVC

UPPER ORDOVICIAN

BIGHORN DOLOMITE	361BGRN
LEIGH DOLOMITE MEMBER OF BIGHORN DOLOMITE	361LIGH

LANDER SANDSTONE MEMBER OF BIGHORN DOLOMITE	361LNDR
UPPER ORDOVICIAN SERIES	361ODVCU

MIDDLE ORDOVICIAN

ALADDIN SANDSTONE	364ALDN
MIDDLE ORDOVICIAN SERIES	364ODVCM

LOWER ORDOVICIAN

DEADWOOD FORMATION	367DDWD
LOWER ORDOVICIAN SERIES	367ODVCL

CAMBRIAN

CAMBRIAN SYSTEM	370CMBR

UPPER CAMBRIAN

BUCK SPRING FORMATION	371BKSP
BOYSEN FORMATION	371BYSN
UPPER CAMBRIAN SERIES	371CMBRU
GALLATIN LIMESTONE OR FORMATION	371GLTN
GROS VENTRE FORMATION	371GRVR
OPEN DOOR LIMESTONE	371OPDR
PILGRIM LIMESTONE	371PLGM
SNOWY RANGE FORMATION	371SNRG

MIDDLE CAMBRIAN

MIDDLE CAMBRIAN SERIES	374CMBRM
DEATH CANYON MEMBER OF GROS VENTRE FORMATION	374DCNN
DEPASS FORMATION	374DPSS
FLATHEAD QUARTZITE OR SANDSTONE	374FLTD
MEAGHER LIMESTONE	374MGHR
PARK SHALE	374PARK
WOLSEY SHALE	374WLSY

PRECAMBRIAN

PRECAMBRIAN ERATHEM	400PCMB

APPENDIX F

HYDROLOGIC UNIT CODES FOR UPPER COLORADO RIVER BASIN REGION

BOUNDARY DESCRIPTIONS AND NAMES OF REGIONS, SUBREGIONS, ACCOUNTING UNITS AND CATALOGING UNITS

REGION 14 UPPER COLORADO REGION -- THE DRAINAGE OF: (A) THE COLORADO RIVER BASIN ABOVE THE LEE FERRY COMPACT POINT WHICH IS ONE MILE BELOW THE MOUTH OF THE PARIA RIVER; AND (B) THE GREAT DIVIDE CLOSED BASIN. INCLUDES PARTS OF ARIZONA, COLORADO, NEW MEXICO, UTAH, AND WYOMING.

SUBREGION 1401 -- COLORADO HEADWATERS: THE COLORADO RIVER BASIN TO BUT EXCLUDING THE BITTER CREEK BASIN, AND EXCLUDING THE GUNNISON RIVER BASIN. COLORADO, UTAH.

ACCOUNTING UNIT 140100 -- COLORADO HEADWATERS: COLORADO, UTAH.

CATALOGING UNITS
14010001 -- COLORADO HEADWATERS. COLORADO.
14010002 -- BLUE. COLORADO.
14010003 -- EAGLE. COLORADO.
14010004 -- ROARING FORK. COLORADO.
14010005 -- COLORADO HEADWATERS-PLATEAU. UTAH.
14010006 -- PARACHUTE-ROAN. COLORADO.

SUBREGION 1402 -- GUNNISON: THE GUNNISON RIVER BASIN. COLORADO.

ACCOUNTING UNIT 140200 -- GUNNISON. COLORADO.

CATALOGING UNITS
14020001 -- EAST-TAYLOR. COLORADO.
14020002 -- UPPER GUNNISON. COLORADO.
14020003 -- TOMICHI. COLORADO.
14020004 -- NORTH FORK GUNNISON. COLORADO.
14020005 -- LOWER GUNNISON. COLORADO.
14020006 -- UNCOMPAHGRE. COLORADO.

SUBREGION 1403 -- UPPER COLORADO-DOLORES: THE COLORADO RIVER BASIN FROM AND INCLUDING THE BITTER CREEK BASIN TO THE CONFLUENCE WITH THE GREEN RIVER BASIN. COLORADO, UTAH.

HYDROLOGIC UNIT CODES

BOUNDARY DESCRIPTIONS AND NAMES OF REGIONS, SUBREGIONS, ACCOUNTING UNITS AND CATALOGING UNITS (CONTINUED)

ACCOUNTING UNIT 140300 -- UPPER COLORADO-DOLORES. COLORADO, UTAH.

CATALOGING UNITS
14030001 -- WESTWATER CANYON. COLORADO, UTAH.
14030002 -- UPPER DOLORES. COLORADO, UTAH.
14030003 -- SAN MIGUEL. COLORADO.
14030004 -- LOWER DOLORES. COLORADO, UTAH.
14030005 -- UPPER COLORADO-KANE SPRINGS. COLORADO, UTAH.

UBREGION 1404 -- GREAT DIVIDE - UPPER GREEN: THE GREEN RIVER BASIN ABOVE THE CONFLUENCE WITH THE YAMPA RIVER BASIN; AND THE GREAT DIVIDE CLOSED BASIN. UTAH, WYOMING.

ACCOUNTING UNIT 140401 -- UPPER GREEN: THE GREEN RIVER BASIN ABOVE THE CONFLUENCE WITH THE YAMPA RIVER BASIN. UTAH, WYOMING.

CATALOGING UNITS
14040101 -- UPPER GREEN. WYOMING.
14040102 -- NEW FORK. WYOMING.
14040103 -- UPPER GREEN-SLATE. WYOMING.
14040104 -- BIG SANDY. WYOMING.
14040105 -- BITTER. WYOMING.
14040106 -- UPPER GREEN-FLAMING GORGE RESERVOIR. COLORADO. UTAH, WYOMING.
14040107 -- BLACKS FORK. UTAH, WYOMING.
14040108 -- MUDDY. UTAH, WYOMING.
14040109 -- VERMILION. COLORADO, WYOMING.

ACCOUNTING UNIT 140402 -- GREAT DIVIDE CLOSED BASIN: THE GREAT DIVIDE CLOSED BASIN. WYOMING.

CATALOGING UNIT 14040200 -- GREAT DIVIDE CLOSED BASIN. WYOMING.

UBREGION 1405 -- WHITE-YAMPA: THE WHITE AND YAMPA RIVER BASINS. COLORADO, UTAH, WYOMING.

ACCOUNTING UNIT 140500 -- WHITE - YAMPA. COLORADO, UTAH, WYOMING.

CATALOGING UNITS
14050001 -- UPPER YAMPA. COLORADO.
14050002 -- LOWER YAMPA. COLORADO.
14050003 -- LITTLE SNAKE. COLORADO, WYOMING.
14050004 -- MUDDY. WYOMING.
14050005 -- UPPER WHITE. COLORADO.
14050006 -- PICEANCE-YELLOW. COLORADO.
14050007 -- LOWER WHITE. COLORADO, UTAH.

UBREGION 1406 -- LOWER GREEN: THE GREEN RIVER BASIN BELOW THE CONFLUENCE WITH THE YAMPA RIVER BASIN,BUT EXCLUDING THE YAMPA AND WHITE RIVER BASINS. COLORADO, UTAH.

HYDROLOGIC UNIT CODES

BOUNDARY DESCRIPTIONS AND NAMES OF REGIONS, SUBREGIONS, ACCOUNTING UNITS AND CATALOGING UNITS (CONTINUED)

ACCOUNTING UNIT 140600 -- LOWER GREEN. COLORADO, UTAH.

CATALOGING UNITS 14060001 -- LOWER GREEN-DIAMOND. COLORADO, UTAH.
14060002 -- ASHLEY-BRUSH. UTAH.
14060003 -- DUCHESNE. UTAH.
14060004 -- STRAWBERRY. UTAH.
14060005 -- LOWER GREEN-DESOLATION CANYON. UTAH.
14060006 -- WILLOW. UTAH.
14060007 -- PRICE. UTAH.
14060008 -- LOWER GREEN. UTAH.
14060009 -- SAN RAFAEL. UTAH.

SUBREGION 1407 -- UPPER COLORADO-DIRTY DEVIL: THE COLORADO RIVER BASIN BELOW THE CONFLUENCE WITH THE GREEN RIVER BASIN TO THE LEE FERRY COMPACT POINT, BUT EXCLUDING THE SAN JUAN RIVER BASIN. ARIZONA, UTAH.

ACCOUNTING UNIT 140700 -- UPPER COLORADO-DIRTY DEVIL. ARIZONA, UTAH.

CATALOGING UNITS 14070001 -- UPPER LAKE POWELL. UTAH.
14070002 -- MUDDY. UTAH.
14070003 -- FREMONT. UTAH.
14070004 -- DIRTY DEVIL. UTAH.
14070005 -- ESCALANTE. UTAH.
14070006 -- LOWER LAKE POWELL. ARIZONA, UTAH.
14070007 -- PARIA. ARIZONA, UTAH.

SUBREGION 1408 -- SAN JUAN: THE SAN JUAN RIVER BASIN. ARIZONA, COLORADO, NEW MEXICO, UTAH.

ACCOUNTING UNIT 140801 -- UPPER SAN JUAN: THE SAN JUAN RIVER BASIN TO AND INCLUDING THE MANCOS RIVER BASIN. ARIZONA, COLORADO, NEW MEXICO.

CATALOGING UNITS 14080101 -- UPPER SAN JUAN. COLORADO, NEW MEXICO.
14080102 -- PIEDRA. COLORADO.
14080103 -- BLANCO CANYON. NEW MEXICO.
14080104 -- ANIMAS. COLORADO, NEW MEXICO.
14080105 -- MIDDLE SAN JUAN. ARIZONA, COLORADO, NEW MEXICO.
14080106 -- CHACO. ARIZONA, NEW MEXICO.
14080107 -- MANCOS. COLORADO, NEW MEXICO.

ACCOUNTING UNIT 140802 -- LOWER SAN JUAN: THE SAN JUAN RIVER BASIN FROM THE MANCOS RIVER BASIN TO THE CONFLUENCE WITH THE COLORADO RIVER. ARIZONA, COLORADO, NEW MEXICO, UTAH.

HYDROLOGIC UNIT CODES

BOUNDARY DESCRIPTIONS AND NAMES OF REGIONS, SUBREGIONS, ACCOUNTING UNITS AND CATALOGING UNITS (CONTINUED)

CATALOGING UNITS 14080201 -- LOWER SAN JUAN-FOUR CORNERS. ARIZONA, COLORADO, NEW MEXICO, UTAH.
14080202 -- MCELMO. COLORADO, UTAH.
14080203 -- MONTEZUMA. COLORADO, UTAH.
14080204 -- CHINLE. ARIZONA, NEW MEXICO, UTAH.
14080205 -- LOWER SAN JUAN. ARIZONA, UTAH.

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